ANNALS OF SURGERY

VOL. XLIV. SEPTEMBER, 1906 No. 3

ORIGINAL MEMOIRS.

THE SERUM THERAPY OF TETANUS.*

BY NATHAN JACOBSON, M.D.,
OF SYRACUSE, N. Y.,
Professor of Surgery in the College of Medicine of Syracuse University;
Surgeon to St. Joseph's Hospital,
AND
HERBERT D. PEASE, M.D.,
OF ALBANY, N. Y.,
Director of the Antitoxin Laboratory, New York State Department of Health.

As the title of this paper indicates, its scope is restricted to a consideration of the therapeutic value of the antitoxin treatment of tetanus. However, it is essential in order to obtain a just estimate of the value of the antitoxic serum that we appreciate certain principles which laboratory investigation seems to have firmly established, and that we study carefully our clinical experiences.

The Tetanus Bacillus.—Tetanus is essentially a dirt disease. Its etiologic agent, the tetanus bacillus, commonly inhabits the surface dirt, and yet it belongs to the class of bacteria incapable of developing in the presence of atmospheric oxygen.

---

*Read before the American Surgical Association, June 1, 1906.

It has been definitely shown by Debrand[1] and others, however, that oxygen-consuming bacteria, by using up the available oxygen in their development, create the proper anaërobic conditions necessary for the growth of the tetanus bacillus. This symbiotic growth of aërobic and anaërobic bacteria is an exceedingly common phenomenon in nature.

The tetanus bacillus and its spores have a most tenacious vitality and can live under natural conditions entirely unfavorable for the existence of most pathogenic bacteria. Living spores can exist in dust and other dry dirt.

The bacillus thrives best at the body temperature, and can develop but little, if at all, below 60° F. On this account it may be assumed that the organism is more active during the summer months. One of us has shown[2] that the large majority of cases of tetanus in New York State occur from May to October, with June, July and August as the months of maximum activity.

That it is a frequent habitant of the intestinal tract of animals, especially horses and cattle, has been amply shown by numerous workers, but more recently by Hoffman.[3] This fact is important, as all wounds received in stables or contaminated with animal discharges are particularly to be feared. Pizzini[4] has also found it in the fæces of man. Tavel[5] and Libman[6] describe an anaërobic spore-forming tetanus-like bacillus in the human appendix.

In this connection reference should be made to the clinical evidence of the source of infection in man being sometimes in the intestinal tract.

In Table I accompanying this paper are five cases following operations performed under aseptic conditions upon the intestines and reported by Brewer (Table I *a*30), Goodrich (Table I *a*44), Willy Meyer (Table L *b*19), Kammerer (Table I *b*20) and Roe (Table I *b*45). Four of them were for the removal of the appendix in the quiescent period, and followed the operation twice nine and once ten and eleven days respectively, while in the fifth colectomy was performed for the removal of a cancer of the splenic flexure.

---

[1] Debrand. Annales de l'Institut Pasteur, 1902, 16, 427.

[2] Pease. Medical Review of Reviews, 1904, x, 524.

[3] Hoffman. Hygienische Rundschau, 1905, xv, 1233.

[4] Pizzini. Quoted by Hoffman.

[5] Tavel. Centralblatt fur Bakteriologie, Erst. Abt. xxiii, 1898, 538.

[6] Libman. Quoted by Buerger. American Journal Medical Sciences, 1905, Series, cxxx, 267.

Rather more difficult of explanation is the portal of entrance of the bacillus in a case reported by Warbasse (Table I *a*36), in which tetanus appeared six days after the performance of supravaginal hysterectomy and double oöphorectomy through an abdominal incision.

That tetanus can readily follow unclean surgical procedure appears in a case reported by Mudd (Table I *c*12) in which it was the sequel of an open operation for varicocele performed by a doctor connected with an advertising institution and admitted into St. Luke's Hospital, St. Louis, after the disease had become established.

In a series of three cases reported by Fourneau as having occurred at the Goettingen klinik[7] one followed a Bassini operation for the radical cure of hernia. This infection was attributed to a case of tetanus cared for on the preceding day. No case of tetanus having occurred in this klinik for seven years, the reporter states that they were thrown off their guard and proper precautions to avoid infection had not been taken.

The danger of the transmission of the disease in hospitals is not generally appreciated. In this country, as far as we are informed, the only hospital in which complete isolation from all other surgical patients is practised is the Pennsylvania, in Philadelphia, where all tetanus cases are transferred to the medical service for treatment.

Conditions of Infection.—The occurrence of idiopathic tetanus is most unlikely. It is essential for the production of the disease that the bacillus either in its vegetative or spore state, or its toxin, must gain entrance into the tissues of the body through some injury to the skin or mucous membrane. The disease is a true intoxication, and the tetanus toxin alone is capable of producing it. Yet tetanus toxin fed to animals is not absorbed as such through the uninjured digestive tract, but is either digested or passed out with the fæces unchanged.

---

[7] Fourneau. Deutsche Medizinische Wochenschrift, 1904, 10.

Once having gained entrance into the tissues, the bacillus is capable of producing its toxin only under certain conditions.

Some years ago Vaillard[8] and more recently Tarozzi[9] showed that the spores of the tetanus bacillus when freed from the toxin before injection into the body did not produce the disease, unless other substances were also injected, or conditions created which would bring about necrosis in the tissues.

While necrosis is essential for infection, neither the incubation, the onset, nor the severity of the attack is strictly dependent upon the amount of visible destruction of tissue or suppuration which takes place. The explanation of this is that minute quantities of tetanus toxin have the most powerful poisonous effect, and but very slight development of the bacillus is required for the production of several fatal doses of the poison. Thus Vincent[10] has recently shown that the subcutaneous injection of small amounts of solutions of quinine and its salts, which contained tetanus spores deprived of their toxin, brought on fatal attacks of tetanus. In these cases the determining factor appeared to be the slight necrosis induced by the quinine injected. He states that tetanus is a frequent sequel to subcutaneous quinine injection, but a rare development after the subcutaneous administration of morphine. The latter drug, he states, does not produce necrosis.

---

[8] Vaillard. Annales de l'Institut Pasteur, 1892, 6.

[9] Tarozzi. Centralblatt fur Bakteriologie Erst. Abt. 1906, XL, Originole 305.

[10] Vincent. Annales de l'Institut Pasteur, 1904, xviii, 748.

Another active factor in the determination of tetanus infection is the presence of aërobic bacteria in the injured area, and the symbiotic development of them and the tetanus bacilli. Thus von Hibler[11] has shown that mildly virulent tetanus bacilli can be enhanced in pathogenic power by coincident mixed infections; Garnier[12] that the injection of typhoid cultures together with tetanus toxin increased the toxic power of the latter, and Zanfroguini[13] that the presence of the colon bacillus and the staphylococcus aureus had the same effect.

Distribution of the Tetanus Bacillus in the Body.—Ordinarily the tetanus bacillus is present in the body only at the site of injury. It has been shown, according to authors quoted by Tarozzi,[9] in a few cases of tetanus in man that the bacillus was found at autopsy in the sciatic nerve, the spinal cord, the medulla oblongata, lymph nodes, cerebrospinal fluid, and spleen, and during life in the circulating blood. Tarozzi by experiment showed that spores injected into animals were found in a live state in the internal organs, especially in the liver, as late as three months afterwards.

Vincent[14] found that if animals which had been injected with solutions containing spores freed from toxin were kept in incubators at high temperatures, that the bacteria were most likely to wander into the circulating blood and would develop and tetanic symptoms would be produced.

Of the sources of infection not yet mentioned is the injection of solutions containing gelatin for the purpose of controlling hæmorrhage. Two such cases are reported[15] as having occurred at the klinik of Helferich in Kiel. In the first instance it was given subcutaneously into the thigh two hours before the performance of laryngectomy to prevent uncontrollable capillary hæmorrhage. This it accomplished. But tetanus appeared six days after, with evident septic disturbance in the thigh. The muscles of the back and lower extremities were particularly convulsed. Death followed promptly, despite the use of the antitetanic serum. The field of operation in the neck showed no evidence of infection.

---

[11] V. Hibler. Centralblatt fur Bakteriologie, Erst. Abt.Ref. xxxvii, 545.

[12] Garnier and Sabareau. Archiv. de Med. Experiment, 1904, 16, 557.

[13] Zanfroguini. Centralblatt fur Bakteriolgie, Erst. Abt. Ref., 1906, xxxvii, 650.

[9] Tarozzi. *Loc. cit.*

[14] Vincent. Annales de l'Institut Pasteur, 1904, xviii, 450.

[15] Deutsche Zeitschrift f. Chirurgie, October, 1901.

In the second case it was used to control secondary hæmorrhage occurring from a subphrenic abscess. After a period of six days severe tetanus appeared, which was fatal in two days.

Period of Incubation.—All the factors mentioned, as determining the occurrence of tetanus, exercise a proportionate influence upon the period of incubation, the character of the onset, the course, and the termination of the disease.

The period of incubation may vary within wide limits. Rose and many others have reported incubation periods as short as twenty-four hours and even less. If what is now quite generally accepted as the path of the poison from the site of its production to the nerve centers is correct, then such cases as have been recorded with periods of incubation under three days must be accepted with considerable reserve.

And yet a case reported by Kuhn of Cassel at the Versammlung Deutscher Naturforscher und Aerzte,[16] offers a new explanation of this group of cases. A boy, a bleeder, had been operated upon for the removal of adenoids from his nasopharynx. The hæmorrhage being uncontrollable, a gelatin injection was given him. At the site of injection gangrene promptly appeared and after twelve hours general tetanus was present, from which death speedily resulted. Schuckmann[17] commenting on this case expresses the opinion that the gelatin injection must have contained a poisonous dose of toxin, the injection of which, rather than the bacillus, caused the death.

---

[16] Berliner Klinische Wochensch., 1901, p. 1118.

[17] V. Schuckmann. Deutsche Med. Wochensch., 1903, March 5.

While a short incubation period usually implies intensity of infection, Warbasse (Table I *a*38) reports the case of a patient 13 years of age, resulting from a punctured wound of the foot, from the penetration of a nail, with an incubation period of but four days. The treatment consisted in the injection of 20 c.c. of antitoxin subcutaneously. The case was one of general tetanus, yet terminated in recovery.

On the other hand in Table I appear seven cases in which the disease did not manifest itself until the nineteenth day in one, the twenty-first day in three, the twenty-fifth day in two and the twenty-sixth day in one. Four of these were treated with subcutaneous injection of the serum, two by intraspinal and one by deep intramuscular injection. All of the cases recovered except the last one. This patient, twenty-five days before, had received a punctured wound of the sole of his foot and entered Johns Hopkins Hospital on the first day of the disease. For a few days he seemed to improve under the serum treatment, and it was discontinued. Death occurred suddenly on the seventh day. This case must be considered as one in which the appearance of tetanus was delayed, but yet in which the infection was virulent when awakened into activity.

In Table II occur three cases with incubation periods of eighteen, nineteen, and twenty-two days respectively. One of them was so mild that recovery would have occurred under any treatment, and in another, the result of a burn, the general condition is stated to have been exceedingly bad and is held responsible for the death. The third recovered, having received 800 c.c. of antitoxic serum in the course of eight days.

It is interesting to note that in only one of these ten cases was a punctured wound responsible for the tetanus, most of them having been due to crushed or lacerated wounds.

The analysis of our tables furnishes some very suggestive facts upon this point. In them will be found 52 cases due to blank cartridge or gunshot wounds, presenting an average incubation period of 7.3 days with a mortality of 76 per cent., and 51 punctured wounds with an average incubation period of 7.9 days, a mortality of 74.5 per cent., while in the 28 lacerated wounds tabulated, the incubation period was 11.8 days and the mortality 53.6 per cent.

We must now consider what occurs during the period which intervenes between the receipt of the injury and the appearance of the first tetanic manifestations.

The relation of toxin to the nervous system.—New light has been shed upon the pathology of tetanus by the researches of Meyer and Ransom[18] and Marie and Morax.[19] Their work has been reviewed so frequently that it is only necessary at this time to recall the main conclusions that have been reached.

The presence of tetanus toxin in the living body causes no symptoms, clinically appreciable, until it has been absorbed by the muscular terminations of the motor nerves, has passed along their axis-cylinders, and has reached the motor root-cells in the spinal cord. While the toxin is in the nerves, or in the spinal cord acting upon the spinal cells, it is effectually isolated from antitoxic substances present in the blood or lymph circulations. If, however, a nerve, or the spinal cord, be injured in such a manner as to expose the axis-cylinders or the nerve-cells to the toxin in the blood or lymph, the affinity of the toxin for such nerve element is soon manifested by awakening a tetanic condition in the part controlled by that nerve or the affected nerve-cells. Odier[20] claims that the toxin has a lytic effect on the outrunners of the motor end-plates, and that it has a somewhat similar effect upon the axis-cylinders of the nerves, proportional to the amount and concentration of the toxin passing through them. In other words, it is apparently possible for the toxin to come in contact with the nerve elements for which it has a strong affinity at only one point, namely, at the termination of the motor-nerves in the muscles. The time taken for the toxin to be absorbed and to pass through the nerves represents the large part of the period of incubation. Courmont and Doyan[21] have shown that the period of incubation in different animals is roughly proportionate to the distance between the termination of a nerve and its central nerve-cell. The early appearance of trismus, in natural infections, can be explained by the fact that the nerve supplying the muscles of mastication is a comparatively short one. Thus, the period of incubation is the net result of the length of nerve and the degree of concentration of toxin at the point of its absorption by the nerve terminals.

---

[18] Meyer and Ransom. Archiv. fur Experimentelle Pathologie und Pharmakologie, 1903, 49, Heft 6.

[19] Marie and Morax. Annales de l'Institut Pasteur, 1902, xvi, No. 11, and 1903, xvii, No. 5.

[20] Odier. Archives de Médecine Experimentale et d'Anatomie Pathologique, 1904, 16, 451.

It is apparently established that the toxin produced at the portal of entry of the tetanus bacillus is absorbed by the muscular terminations of the motor-nerves of the part as well as the lymphatics, is transported directly through the axis-cylinders of the nerves to the cord, and also by an indirect route through the lymphatics to the blood and thence by way of other nerve fibres to the spinal cord.

Tetanus antitoxin.—There is not the slightest question of the power of tetanus antitoxin to neutralize free tetanus toxin outside the body or in the circulating blood or lymph channels. To what extent it can release the organ-bound toxin has not yet been determined. There is no experimental nor clinical evidence that it has any effect on the toxin passing along the axis-cylinders of the nerves, even if it is present in large amounts in the circulating blood.

The histologic arrangement of the parts prevents the toxin present in the blood and lymph from acting directly upon the sensitive nerve-cells, despite its apparent propinquity. This same condition affords an effective barrier, which likewise prevents the neutralization of the toxin by the antitoxin when once the latter has passed into the axis-cylinders and has reached the nerve-cells.

---

[21] Courmont and Doyan. Quoted by Marie and Morax.

The absence of a standard method of expressing the antitoxic strength of tetanus antitoxin renders it impossible to properly estimate the exact amount administered in a given case and materially interferes with our reaching definite conclusions in this regard in studying the accompanying tables.

A committee has been appointed by the Society of American Bacteriologists, to whom this matter has been referred, and we shall have, therefore, before long a standard serum of known strength.

While in the cases reported in this paper an effort has been made to specify the names of the producers of the antitoxin used, no comparison of the relative merits of the different varieties has been attempted.

A review of our tables will indicate that in many instances what might be considered large doses have been freely administered, and aside from the occasional occurrence of urticaria or dermatitis no ill effects have been noted.

Preventive Injections.—From what has been said, it is quite evident that antitoxin to be of the greatest service must be administered before the motor-nerves have absorbed any toxin. The serum should, therefore, be administered as soon after the infliction of the injury as possible, and should be given to every person who has sustained an injury in which dirt, manure or foreign substance could possibly have been carried into the wound. Injuries received by persons whose labor brings them in contact with the soil, or whose work is among domestic animals, should be regarded as suspicious and should receive the tetanus antitoxin as a part of the routine treatment.

These preventive injections should, however, be given intelligently, and the size of the injection, the site chosen, and its repetition, should be regulated by the character and location of the injury.

Injuries involving the nerve-trunks should be treated with antitoxin locally as well as subcutaneously, in order to avoid the direct absorption of toxin by such injured nerves. For this purpose either liquid or dried antitoxin is suitable.

In injuries considerably contaminated by dirt the prophylactic dose given at the first dressing should be repeated on the third and fifth days, and again from the fifteenth to the twentieth day if suppuration still continues. The passive immunity conferred by a single prophylactic injection of tetanus antitoxin undoubtedly is of no longer duration than is that given by a similar injection of diphtheria antitoxin. This on the average is from three to four weeks. Yet the protection may be but for a few days. The virulence of the toxin may be maintained, although the outbreak of tetanus is deferred. As evidence of this, Sejour[22] reports a fatal case of only twenty-four hours' duration, the onset of which occurred twenty-two days after the injection of a prophylactic dose in a case of compound fracture.

Suter[23] reports a case of tetanus occurring forty-seven days after the use of one prophylactic dose. He has collected eleven other cases from literature.

We are able to add six cases to this list from reports made to us personally. They are, briefly, as follows:

Case I.—Age 8; reported by Dr. A. J. Ochsner; treated at St. Mary's Hospital, Chicago. Compound comminuted fracture of the left leg. One injection of 10 c.c. antitoxin of French make given sixteen hours after injury. No unfavorable symptoms until the twelfth day, when trismus and opisthotonos appeared, but which subsided after forty-eight hours; the patient then making an uneventful recovery.

---

[22] Sejour. Gazette des Hopitaux, 1905, lxxviii, 606.

[23] Suter. Archiv fur klinische Chirurgie, 1904, lvxx, 113.

Reference Centralblatt fur Bakteriolgie Erst. Abt. Referate, 1906, xxxvii, 675.

Case II.—Reported by Dr. Leonard Freeman, of Denver, Colo., the injury being a punctured wound of the foot due to a nail; 10 c.c. were given several hours after the injury. Local irritation and a pronounced general erythema lasting several days occurred. Six days later there was mild trismus, with soreness of the shoulders and legs. Recovery.

Case III.—Occurred at the Pennsylvania Hospital, Philadelphia, in the service of Dr. James Tyson. The patient, forty-eight years of age, received a punctured wound in the palm of the right hand caused by a rusty nail. Four days later 30 c.c. of antitoxin were injected about the wound. On the eighth day there was pain and stiffness of the corresponding arm and forearm, associated with painful mastication. This disappeared in the course of three days.

Case IV.—Dr. J. H. Branan, Albany, N. Y., cared for a boy fourteen years old, who received on July 4, 1905, a lacerated wound of the hand from the premature explosion of a cannon. Tetanus bacilli were found in a smear taken from the middle finger. He received an intramuscular injection of 10 c.c., July 7, and a like injection July 15. Between these latter dates he suffered from stiffness of the jaws and of the neck muscles, which cleared up and the patient recovered.

Case V.—Dr. L. L. McArthur, of Chicago, contributes the fifth to this list of cases. The patient was injured in a street-car accident, having been rolled, crushed, and then dragged a distance before being rescued. A compound comminuted fracture of the skull resulted, dirt being ground into the wound. Both upper and lower extremities had open comminuted fractures. The injured parts received thorough surgical attention, and were made clean. On the first, second and third days she received 30 c.c. of Behring antitoxin. On the eleventh day, the wounds having done well, the scalp wound was drawn together by suture. Two days later there was a rise of temperature to 102°, and on the following day, the fourteenth after the receipt of the injury, there was trismus so that the jaws could be separated only three-eighth of an inch, and stiffness of the neck; 20 c.c. of antitoxic serum were administered. The next day an injection of 30 c.c. was given. From this time on there was a disappearance of the tetanic manifestations.

Case VI.—Dr. James Bell (Table I *b*47) reports the case of a patient, aged 9, treated in the Royal Victoria Hospital, Montreal. He had sustained a contused and lacerated wound of the skin over the tibia and was given 5 c.c. of antitetanic serum as a prophylactic injection on the day following the injury. Although tetanus did not appear until the forty-seventh day thereafter, it was so virulent as to cause death in five days.

It is to be noted, however, in all of these cases with the exception of the sixth, that the toxin was so modified in its intensity that the tetanic symptoms were of short duration and in each instance the patient recovered. In the latter, however, although the outbreak was delayed, the virulence of the toxin persisted.

Letters received from members of this association indicate that it is the practice in the hospitals of New York, Chicago, Baltimore, Cincinnati, Cleveland, Boston, Montreal, Brooklyn and Albany to use the antitoxin prophylactically and to inject it usually subcutaneously, although in Cleveland it is given into the spinal canal, in all of the cases in which it is believed that there is danger of the development of tetanus, and with the exceptions mentioned the disease has never appeared after such injection.

At the fifteenth congress of French surgeons the treatment of tetanus was most exhaustively considered.[21] The subject was presented by M. Vallas, of Lyons. Speaking of the preventive power of the injections of the antitoxic serum, he is most emphatic in his decision that it is an agent of such positive value that with its constant use tetanus would cease to exist altogether.

No one will pretend to claim that the prophylactic injections are to take the place of the efforts to be made in each instance to render the parts thoroughly clean at the primary dressing, or to remove all possible infected tissues.

In many hospitals reliance is placed upon these procedures, and indeed this has been the policy in the hospital with which one of us is connected. In this hospital several hundred cases of wounds of such character as might have been followed by tetanus have been thus treated, and yet there has been no occurrence of that disease since 1899.

We have received the report of a number of cases treated at various of the large hospitals of the country, where excision of the infected area was practised when possible, and thorough cleansing and disinfection where this could not be done and where no serum has been used, yet tetanus has not occurred. This subject has also been considered by Bain[25] and Richardson.[26]

---

[21] Association Francaise de Chirurgie, 1903.

In the cases reported by the latter, however, the use of the antitoxic serum was combined with thorough surgical attention.

This combination of procedures is the one which should be pursued. The prophylactic injections should be given directly into the muscles, as this method affords more rapid absorption than when carried only into subcutaneous tissues as has been shown by Meltzer and Auer.[27] The injection of antitoxin into adipose tissue, as is frequently done, is probably a waste of effort and material.

The necessity of giving these injections early, so that they may indeed be protective, is made exceedingly clear when we realize that if the necessary time elapses after the introduction of the bacilli for the development of a sufficient amount of toxin, not even amputation will prevent the appearance of tetanus.

Two cases in Table I illustrate this point. In the first (Table I *b*23) a man sustained a compound fracture of the leg April 24, 1902, because of which the leg was amputated at the New York Hospital April 30th. Despite this, tetanus appeared May 3, and death occurred the next day.

In the second (Table I *a*52) a man run over by an electric car December 26, 1905, was brought three and one-half hours later into the Massachusetts General Hospital. The wound became septic, and amputation was performed December 30th. The next day the temperature rose to 105, the neck became rigid and dysphagia appeared. Despite antitoxin, then given subcutaneously, he died January 3, 1906.

Local Tetanus.—Before considering the therapeutic use of tetanus antitoxin, there remain some points to be emphasized which have a bearing thereon.

---

[25] Bain. ANNALS OF SURGERY, 1903, Vol. 37, 399.

[26] Boston Medical and Surgical Journal, 1905, Vol. 152, 493.

[27] Meltzer and Auer. Journal of Experimental Medicine, 1905, 7, 59.

Tetanus provoked in animals as a result of experimentation exhibits almost without exception as its earliest manifestations those of a purely local character and which are at first restricted to the neighborhood of the inoculation. This is now understood to be due to the absorption of the toxin by the motor-nerve of the part. The conditions favoring the local appearance of tetanus are a short motor-nerve as in head injuries; an injury to a nerve-trunk permitting the rapid absorption of a large amount of toxin; the production of a meager amount of toxin or the presence of something which prevents the admission of a large amount of toxin into the circulation.

Axhausen[28] reports eleven cases in man with but a single death in which distinct local tetanic symptoms preceded the usual manifestations. After studying these cases he concluded that they had a long incubation period averaging twenty days, that the symptoms were slow to develop and likewise to decline. In Table I will be found ten cases in which local manifestations in the part injured preceded the other evidences of tetanus.[29] Three of them resulted from head or face injuries, all recovering; two were blank cartridge wounds of the hand, one recovering; one a lacerated hand; two gunshot wounds of the thigh; one due to an abrasion of the shin; and one to a penetrating wound of the foot. The two latter recovered. The average incubation period of this group was only 9.2 days, however. Six of them recovered, showing a mortality of only forty per cent. Our cases, therefore, verify in the main the statements of Axhausen, although the mortality was considerably higher.

Classification of Cases.—Recognizing the fact as previously stated that the length of the incubation period is as a rule a good index of the virulence of the infection, for the purpose of estimating the value of the serum treatment we have divided the cases herewith submitted into two classes and shall speak of those as acute in which the incubation period was of less than ten days' duration, and of those as subacute when it was ten days or longer.

---

[28] Axhausen. Deutsche Zeitschrift fur Chirurgie, 1905, 78, 265.

[29] Table I *a*, Cases 16, 17, 24, 28, 42, 45. Table I *b*, 7, 21. Table I *c*, 8. Table I *d*, 2.

Believing that it is but natural that men would as a rule be more apt to publish their successes than their failures, we have not attempted to collect from literature the cases of tetanus which have been subjected to serum treatment. Two tables, however, are presented. The first represents the experiences gathered from many of the large hospitals of the United States. It is believed that as the table includes all of the cases treated at these institutions, and in a few instances in the private practice of their surgeons, a truer estimate of the real worth of the antitoxic serum could thus be obtained. The second covers all of the cases treated in New York State in which the State Department of Health furnished antitoxin. The data for this group of cases are furnished by Dr. Pease, one of the writers of this paper, who is the director of the antitoxin laboratory of this state.

In Table I there are 144 cases, in No. II 59, placing at our command 203 cases. Of those in Table I, 66 were treated by subcutaneous injection; 48 by injection of the serum into various structures; 12 by intraspinal; 16 by intramuscular; one by intracerebral, and one by intravenous injection.

Of the 59 cases in Table II, 42 were treated subcutaneously; 16 by injection into different tissues, and 1 by intracerebral injection.

In Table I there were 93 acute cases, the termination being known in 91. Of these 78 died, a mortality of 85.7 per cent. The number of subacute cases in this table is 44. The final result is given in 43. There were 15 deaths, a mortality of 34.9 per cent. In six the incubation period is not mentioned.

In Table II the termination was given in 36 acute cases; 29 died, mortality 80.6 per cent. Of 21 subacute cases in which the result is given there were 11 deaths, a mortality of 52.4 per cent.

The mortality attending the various methods of administering the antitoxin shows the following in Table I:

Of 66 cases treated by subcutaneous injections, the incubation period is not mentioned in one case. Of the remaining 65, 47 were acute cases, the termination being known in 46. Of these 38 died, mortality 82.6 per cent. 18 were subacute, of which but four died, mortality 22.2 per cent.

In 48 cases treated by a combination of either subcutaneous, intraneural, intraspinal, intravenous or intracranial injections, the result is mentioned in 47. Of these 30 were acute, the termination being known in 29; 27 dying, a mortality of 93.1 per cent; 14 were subacute cases, of whom 7 died, mortality 50 per cent.

By intraspinal injection 12 were treated, in one the incubation period not being stated; seven were acute cases, 4 dying, mortality 57.1 per cent. In three subacute cases, in which the result was known, all recovered. Of 16 cases treated by intramuscular injection, in one the incubation period is not given. Of the remaining 15, 7 were acute, all dying; mortality 100 per cent. Of the remaining 8 subacute cases, 4 died; mortality 50 per cent.

In Table II a study of the cases results as follows: By subcutaneous injection 42 were treated; the incubation period was known in 40, and of this number 24 were acute, of whom 19 died; mortality 79.2 per cent. Of the 16 subacute cases thus treated, 7 died; mortality 43.8 per cent.

Sixteen were treated by the injection of the antitoxin into the several structures mentioned in a previous paragraph. Eleven were acute cases, 9 dying; mortality 81.8 per cent.; while of 5 subacute cases four died, a mortality of 80 per cent.

In each table there is recorded a single case treated by intracerebral injection alone. Both patients died.

In Table I there appears one acute case treated by intravenous injection. This patient died.

The tables were carefully analyzed for the purpose of studying the degree of virulence of the cases treated by the different methods, and it appears that a larger percentage of cases with a short period of incubation, rapid progress and an early death, were treated by subcutaneous injection than by any other method.

As to the amount of antitoxin injected, in but 20 cases were more than 500 c.c. administered. These cases had an average incubation period of 10.8 days ; 15 recovered and 5 died, a mortality of 25 per cent. Five of the 15 recovering had short periods of incubation. The treatment was begun in these cases on an average 3.3 days after the appearance of tetanic symptoms, and the average length of its continuance was 7.4 days. The largest amount of antitoxin given a single patient was 1495 c.c. Of the 20 cases, seven are found in Table I, with two deaths, mortality 28.6 per cent.; and 13, with three deaths, mortality 23 per cent., in Table II.

It is apparent that the amount of antitoxin administered to these patients is not the only factor to be considered in their recovery, for as a group they belong to the subacute class.

It should be stated that in most of the cases included in our tables medicinal treatment was given in addition to the serum. Occasionally it will be noted that the reporter has commented to the effect that he attributes in a given case quite as much to the drugs as the serum.

Reference might here be made to the paper by Anders and Morgan.[30] It is based upon 252 cases, in 115 of which the antitoxic serum was used. But the details of its use are so meagerly stated that we are not able to estimate its worth in the cases quoted. A few of these cases appear in our Table I. However, their conclusions as to the value of serum therapy do not differ materially from those we are compelled to reach.

---

[30] Anders and Morgan. Journal of the American Med. Asscn., July 29, 1905.

Treatment of Tetanus.—From the facts here presented, it is apparent that after tetanus is fully established serum therapy, however administered, promises but little as a curative agent.

A word as to the special methods of injection. The intracerebral method first practised with apparent success by Roux and Borrel[31] experimentally in animals, was received for a short time with favor by the profession. The results obtained by it were not particularly encouraging. The two cases reported in our tables as having been treated by intracerebral injection alone, both died. Table I *b* contains a list of 11 cases treated by a combination of subcutaneous and intracranial injections. Four of these cases received also intravenous injections. Of the 11 thus treated, but one recovered, a mortality of 91 per cent.

The method has nothing particularly to commend itself as a means of reaching either the free toxin or that fixed to cells of the nervous system. Moreover, it is not devoid of danger, as in the case reported by Gibb[32] first as cured and later[33] as having died of cerebral abscess. At the autopsy each frontal lobe contained an abscess cavity, the left one communicating with the left lateral ventricle, and through the great transverse fissure with the cerebellar fossæ. Every effort was made, we are assured, to perform the operation aseptically. The serum was believed to have been sterile. The suppurating condition was attributed to the frequent repetition of the injection.

The injection of tetanus antitoxin into the subdural space by means of lumbar puncture was devised by Blumenthal and Jacob.[34] This method has been used extensively.

---

[31] Roux and Borrel. Annales d l' Institut, 1898, 12, 225.

[32] Wm. F. Gibb. British Med. Journal, April 15, 1899.

[33] Wm. F. Gibb. British Med. Journal, July 1, 1899.

[34] Blumenthal and Jacob, Berliner klinische Wochenschrift, 1898, 32, 1079.

Without carefully analyzing the cases in our table I *c*, we might be led to estimate the value of this method above its real worth. It should be noted, however, that two of the cases had an incubation period of twenty-one and twenty-six days respectively, both recovering, and that in the four cases reported by Luckett, all of whom recovered, the reporter lays greater stress upon the withdrawal of the cerebrospinal fluid than upon the injection of the antitoxin. This was done because the claim is made that it is rich in toxin and that by its withdrawal a large amount of toxin is removed. That this assumption is unwarranted appears from the investigations of Jacob and Blumenthal,[35] Meyer and Ransom,[18] Millian and Legros.[36] Luckett withdrew 161 m., 605 m., 1556 m., and 3610 m., of spinal fluid in these cases respectively. Moreover, it will be noted that in two of his cases local tetanus preceded the general manifestations, a condition which we have shown indicates a mild attack of tetanus; while a third case (No. 9 of this table) it appears to us cannot be absolutely regarded as one of tetanus, and his fourth case is to be classed as subacute, judged by the incubation period.

The injection of antitoxin into the subdural space offers but little prospect of reaching the affected nerve-cells because of the protection offered by the pia mater. It has been demonstrated that even the tetanus toxin injected into the subarachnoid space does not reach the nerve-cells directly.

For this reason it has been suggested that the antitoxin be carried more deeply, and that it be introduced either into the cord or the cauda equina. Rogers[37] has practised this method in connection with intraneural and intravenous injections in six cases, with three recoveries. A seventh case included in his report occurred in a patient who punctured his left wrist with a hook July 2, 1904, and the palm of his right hand with the same hook July 10, 1904. He was not admitted into the hospital until August 10, 1904, so that there was an incubation period of not less than thirty-one and it might have been as long as thirty-nine days. This patient received a single injection into the nerve-trunks of each upper extremity of five and ten minims respectively and 10 *c.c.* subcutaneously in the neighborhood of the wound in each extremity. It seems to us that this case should be considered apart from the others. Of the other three recoveries one had an incubation period of sixteen days and ran a mild course, while the other two were acute cases and the results obtained were most gratifying.

---

[35] Jacob and Blumenthal. Berlin, Kl. Wochensch., 1898, 49.

[18] Meyer and Ransom. *Loc. cit.*

[36] Milian and Legros. Soc. de Biol., March, 1901.

[37] Rogers. Journal of Amer. Med., Apl., July 1, 1905.

The three fatal cases were all due to crushing wounds of the extremities; two having incubation periods of ten and eleven days respectively, and one of six days.

Meyer and Ransom[18] recommended that attempts be made to neutralize the toxin present in the large nerve-trunks by the injection of antitoxin into them, and reported one case in which an attack of local tetanus was relieved by the injection of antitoxin into the motor-nerves controlling the tetanized region.

Kuster[38] reported to the German Surgical Congress at its session in 1905, a similar case of localized tetanus which was relieved by injections of the proper nerves. In reviewing this case he expressed the opinion that intraneural injections could be of benefit only while tetanus is localized. Kocher and other German surgeons in the course of the discussion endorsed this view, agreeing that only the toxin present in the injected nerve could be thus neutralized. It is even doubtful whether it is possible to neutralize any considerable portion of the toxin in a given nerve by intraneural injections. Fletcher[39] has shown very definitely that it is not an easy matter to inject a nerve-trunk so that any large number of its axis-cylinders become exposed to the fluid injected. In several of his experiments in which toxin was injected into nerves the poison passed directly into the lymph-spaces of the endoneurium and did not reach any of the axis-cylinders, for no tetanus resulted. Only when he injured a considerable number of the axis-cylinders of the nerve by his injection did he succeed in producing absorption of the toxin by the axones.

---

[18] Meyer and Ransom. *Loc. cit.*

[38] Kuster. Abstract of proceedings of German Surgical Congress, 1905.

[39] Fletcher. Brain, 1903, 26, 383.

Theoretically, if antitoxin comes in contact with a marked number of the axis-cylinders of an injected nerve-trunk, the symptoms in the region controlled by that nerve should cease very shortly and not recur. This is what took place in Kuester's case, for there occurred a subsequent painful myositis of the muscles supplied by the injected nerves. Intraneural injections no doubt interrupt the current through the axis-cylinders because of the mechanical pressure they produce, and thus prevent the absorption of the toxin for the time being.

But a word is necessary, in conclusion, to summarize the results of serum therapy in the light of the laboratory studies referred to and the clinical experiences herewith submitted. As a prophylactic measure it merits our fullest confidence, but as a therapeutic agent after tetanus is fully established we are forced to admit that as yet no method has been discovered whereby it can be administered so as to reach effectively the toxin not free in the blood or lymph.

CASES OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM ADMINISTERED BY SUBCUTANEOUS INJECTION.

CASE 1.—KEEFE, Rhode Island Hospital. Age 23. Punctured wound of foot by rusty nail. Tetanus bacilli found. Period of incubation, 5 days; trismus—rigidity of cervical muscles; general convulsions 3 days later; treatment began second day; continued 2 days. Subcutaneous injection of antitoxic serum, first day: 2 injections, 30 c.c. each, = 60 c.c.; second day: 5 injections, 60 c.c. each, = 300 c.c. Total amount injected, 360 c.c. Death on third day after admission.

CASE 2.—HERSEY, Rhode Island Hospital. Age 51. Small punctured wound of scalp; rusty nail. Tetanus bacilli found. Period of incubation, 7 days; trismus; general convulsions next morning; treatment began first day; continued 1 day. Subcutaneous injection of antitoxic serum, one injection, 40 c.c. Total amount injected, 40 c.c. Sudden convulsion next morning and death.

Case 3.—Munro, Rhode Island Hospital. Age 10. Blank cartridge wound of hand; 4th of July accident. Period of incubation, 8 days; trismus; stiffness cervical and spinal muscles; treatment began third day; continued 1 day. Subcutaneous injection of antitoxic serum, in several injections, 300 c.c. Total amount injected, 300 c.c. Course and termination unknown.

Case 4.—Hersey, Rhode Island Hospital. Age 44. Two fingers crushed by falling log. Period of incubation, 21 days; moderate trismus and rigidity of neck, slight opisthotonos; general convulsions frequent but slight; treatment began first day; continued 4 days. Subcutaneous injection of antitoxic serum, 8 injections daily, 40 c.c. 'Total amount injected, 1280 c.c. Dismissed cured after 20 days.

Case 5.—Godding, Rhode Island Hospital. Age 59. Burn of both feet, second degree. Tetanus bacilli found. Period of incubation, 9 days; delirium, trismus; treatment began second day; continued 1 day. Subcutaneous injection of antitoxic serum, 2 injections, 20 c.c. each. Total amount injected, 40 c.c. Death one-half hour after second injection.

Case 6.—Munro, Rhode Island Hospital. Age 55. Right thumb crushed working in lumber yard. Period of incubation, 5 days; trismus; general convulsions 2 days later; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 1 injection, 20 c.c. Total amount injected, 20 c.c. Death three and a half hours later.

Case 7.—Mitchell, Rhode Island Hospital. Age 50. Wound of bridge of nose; fall on stairs. Period of incubation, 12 days; 7 days after injury slight twitching of jaw muscles—disappeared; trismus twelfth day; treatment began third day; continued 10 days. Subcutaneous injection of antitoxic serum, first day, 1 injection, 40 c.c.; second to ninth days, every 6 hours, 20 c.c. Total amount injected, 760 c.c. Left hospital on 25th day; weak and with slight trismus persisting.

Case 8.—Roswell Park; private patient. Age 21. Toy pistol; second finger left hand. No tetanus bacilli found. Period of incubation, 10 to 11 days; trismus; soreness muscles back of neck; dysphagia; treatment began second day; continued about 15 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 3 injections, 10 c.c. = 30 c.c.; afterwards 1 to 2 injections, 10 c.c. each until 27 had been given. Total amount injected, 270 c.c. Recovered.

Case 9.—M. W. Raynor, Newark City Hospital, Newark, N. J. Age 11. Punctured wound of foot; rusty nail. Tetanus bacilli found. Period of incubation, 8 days; trismus, extreme opisthotonos, T. = 101°–102.5°, dysphagia, general pain, retained urine, delirium; general convulsions; treatment began on first day; continued 12 days. P. D. & Co.'s and Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, first day, one injection, 40 c.c.; second to seventh days, every 4 hours, 30 c.c.; next 2½ days, every 6 hours, 20 c.c.; last 2 days, every 8 hours, 10 c.c. Total amount injected, 1380 c.c. Recovered.

Case 10.—Geo. Tully Vaughan, Emergency Hospital, Washington, D. C. Age 27. Punctured wound left foot; rusty nail. Period of incubation, 7 days; trismus; stiffness of neck, cramps in abdomen, weak mucous râles; P. = 90-120; T. = 99°-102°; general convulsions; treatment began fourth day; continued 4 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 15 injections of 20 c.c. each in 4 days. Total amount injected, 300 c.c. Pneumonia on sixth day and death on eighth day.

Case 11.—Geo. Tully Vaughan, Emergency Hospital, Washington, D. C. Age 59. Compound comminuted fracture left leg; wound suppurated. Period of incubation, 11 days; trismus, dysphagia; treatment began on second day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 7 injections in 2 days, 20 c.c. each. Total amount injected, 140 c.c. Death in severe general convulsions on second day.

CASE 13.—GEO. TULLY VAUGHAN, Emergency Hospital, Washington, D. C. Age 33. Punctured wound sole of foot; nail. Period of incubation, 5 days; trismus, rigidity of abdomen and back; general convulsions; treatment began on second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 8 injections; 25 c.c. every 3 hours. Total amount injected, 200 c.c. Death 24 to 36 hours after appearance of symptoms.

CASE 13.—GEO. TULLY VAUGHAN; private. Age 25. Calf right leg impaled on rusty hook. Period of incubation, 7 days; complete trismus, next day cramps in abdomen; treatment began on second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 8 injections; 25 c.c. q. 3 hours. Total amount injected, 200 c.c. , Death on third day.

CASE 14.—C. B. G. DE NANCREDE, University of Michigan Hospital. Age 16. While working in livery barn stepped on nail. Puncture wound of right foot. Period of incubation, 7 days; felt ill on seventh day; pronounced tetanic convulsions ninth day after injury; treatment began on fourth day; continued 3 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 18 injections; 10 c.c. q. 4 hours. Total amount injected, 180 c.c. Leg amputated; death on sixth day.

CASE 15.—C. B. G. DE NANCREDE, University of Michigan Hospital. Age 15. Contused wound from explosion of cannon cracker, 4th of July. Tetanus bacilli found. Period of incubation, 6 days; fifth day pain in region of œsophagus; sixth day, trismus; general convulsions; treatment began first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 6 injections; 10 c.c. q. 4 hours. Total amount injected, 60 c.c. Arm amputated; death on third day.

CASE 16.—LEONARD FREEMAN, St. Joseph's Hospital, Denver, Col. Age 55. Superficial excoriation of skin. No tetanus bacilli found. Period of incubation, 21 days; cramps in leg; trismus; right arm cramped; T. = 99°–100°; treatment began on third day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 15 c.c., repeated in 6 hours, and twice thereafter at 8 hour intervals. Total amount injected, 60 c.c. Recovery; attributed to medicines given and not to serum.

CASE 17.—PATCH, Montreal General Hospital. Age 27. Lacerated wound, bridge of nose, abrasion of face. No tetanus bacilli found. Period of incubation, 6 days; fourth day—twitching, both sides of face, stiffness of eyelids; fifth day, worse; sixth day, trismus; no stiffness of neck muscles, superficial reflexes normal; (entered hospital this day); T. = 102°–104°; later stiffness of neck and back; some opisthotonos; treatment began on third day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first injection, 20 c.c.; afterwards every 6 hours—27 injections. Total amount injected, 300 c.c. At first grew worse, then gradual improvement and ultimate recovery.

CASE 18.—JOHN C. MUNRO, Boston; private. Age 19. Lacerated finger; crushed by door. No tetanus bacilli found. Period of incubation, 9 days; ninth day, sore throat, headache and dysphagia; eleventh day, trismus, and later (same day) opisthotonos; treatment began on second day; continued 2 days. Subcutaneous injection of antitoxic serum given by attending physician; amount not known. Death.

CASE 19.—F. E. BUNTS, Cleveland; private. Age 10. Lacerated right eyebrow and lid. Fall from street car—dirt ground in. No tetanus bacilli found. Period of incubation, 9 days; ninth day, moderate degree of trismus; tenth day, swallowing water produced violent spasm and opisthotonos; general convulsions; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours, 6 injections. Total amount injected, 60 c.c. Death on third day.

CASE 20.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 18. Blank cartridge wound of hand. Tetanus bacilli found. Period of incubation, 7 days; painful spasms of face, neck, back, and extremities; hypersensitive; treatment began first day; continued 36 hours. P. D. & Co.'s antitoxin used.

Subcutaneous injection of antitoxic serum, 7 injections; 10 c.c. q. 4 hours. Total amount injected, 70 c.c. Death after 30 hours.

CASE 21.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 12. Blank cartridge wound of hand. Part of wad still in hand on admission. No tetanus bacilli found. Period of incubation, 8 days; muscles of lower jaw, face, neck and abdomen rigid on admission; general convulsions; treatment began on second day; continued 6 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 20 injections, 10 c.c. q. 6 hours for 5 days. Total amount injected, 200 c.c. Death on seventh day.

CASE 22.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 13. Blank cartridge, left hand. Opened, cauterized, packed, July 4th. No tetanus bacilli found. Period of incubation, 7 days; neck stiff; throat felt queer; not marked on admission; treatment began on first day; continued 5 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 18 injections; 10 c.c. q. 6 hours for 5 days. Total amount injected, 180 c.c. Death on fifth day.

CASE 23.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 8. Blank cartridge wound of scrotum. Admitted on seventh day. No tetanus bacilli found. Period of incubation, 7 days; head retracted; trismus; general convulsions; treatment began on first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, single injection, 5 c.c. Total amount, 5 c.c. Death following morning, 2 A.M.

CASE 24.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 8. Blank cartridge wound palm of right hand. No tetanus bacilli found. Period of incubation, 7 days; slight contractions fingers injured hand; characteristic cry at intervals; next day head retracted; slight trismus; treatment began first day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 8 injections, 10 c.c. q. 6 hours. Total amount injected, 80 c.c. Death on third day.

CASE 25.—ED. H. OCHSNER, Augustana Hospital, Chicago. Age 12. Gunshot wound through hypothenar eminence left hand. No tetanus bacilli found. Period of incubation, 13 days; moderate degree trismus and opisthotonos; treatment began first day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. at 6 and 11 P.M. Next day 8 A.M., 3 P.M., 11.30 P.M., and 10 A.M. following day. Total amount injected, 60 c.c. Gradual recovery.

CASE 26.—EMMET RIXFORD, Lane Hospital, San Francisco. Age 35. Punctured wound of foot. Patient farm hand. Nail passed through shoe. No tetanus bacilli found. Period of incubation, 12 days; facial contortion first, then mild trismus and spasm of trapezius, neck and abdomen; treatment began eleventh day; continued 3 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 7 injections q. 10 c.c. Total amount injected, 70 c.c. Chloral and bromides also used. Recovery in 27 days.

CASE 27.—EMMET RIXFORD, Lane Hospital, San Francisco. Age 14. Lacerated wound of leg opening knee; compound fracture fibula. Head of bone covered with manure. No tetanus bacilli found. Period of incubation, 7 days; violent spasms including respiratory tract—opisthotonos; general convulsions; treatment began second day; continued 3 days. P. D. & Co.'s and Pasteur Institute antitoxin used. Subcutaneous injection of antitoxic serum, second day, 10 c.c.; third day, 20 c.c.; fourth day, 10 c.c. Total amount injected, 40 c.c. Death on fourth day.

CASE 28.—EMMET RIXFORD, Lane Hospital, San Francisco. Age 50. Perforating wound of lower lip. No tetanus bacilli found. Period of incubation, 7 days; mild—limited to face and neck; so mild that diagnosis questioned; no general convulsions; treatment began second day; continued 6 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, for 3 days q. 6 hours, and following 6 days q. 12 hours, 10 c.c. at each injection. Total amount injected, 180 c.c. Sodium bromide also given. Marked erythema. Recovery.

Case 29.—**Geo. E. Brewer**, Roosevelt Hospital, New York. Lacerated wound of posterior and inner right arm; caught in machinery cogs. No tetanus bacilli found. Period of incubation, 19 days; mild trismus; no dysphagia; opisthotonos 2 days later following incision; treatment began second day; continued 10 days. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, first injection 10 c.c. into abdominal muscles, then q. 6 hours for 7 days, 10 c.c. On eighth and ninth days 2 injections 10 c.c. and on tenth day 1. Total amount injected, 340 c.c. Gradual improvement. Recovery in 47 days.

Case 30.—**Geo. E. Brewer**, Roosevelt Hospital, New York. Age 28. Elliptical incision, site of appendectomy wound 5 years old. Incision for ventral hernia. No tetanus bacilli found. Period of incubation, 11 days; eleventh day, trismus; twelfth day, rigidity of arms and neck; very weak; later same day total rigidity; treatment began first day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 4 injections, 15 c.c. q. 4 hours into abdomen. Total amount injected, 60 c.c. Death on third day.

Case 31.—**B. F. Curtiss**, Bellevue Hospital, New York. Age 43. Compound comminuted gunshot wound of anterior side of foot. No tetanus bacilli found. Period of incubation, 7 days; stiffness lower jaw, next day almost complete trismus, by night stiffness of back; general convulsions; third day very severe; controlled by chloroform; treatment began first day; continued 3 days. Subcutaneous injection of antitoxic serum, first day, at 4 P.M., 9 P.M. and 12 P.M., 20 c.c.; second day, 6 injections q. 20 c.c.; third day, 20 c.c. q. 4 hours. Total amount injected, 300 c.c. Death on third day.

Case 32.—**H. B. Williams**, New York Hospital. Age 14. Blank cartridge wound of hand, July 4th, 1904. Tetanus bacilli found. Period of incubation, 9 days; mild at first, rapidly becoming severe; general convulsions; treatment began second day; continued 6 days. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, second day, 6 P.M., 10 c.c., 9 P.M., 15 c.c., 12 P.M., 15 c.c.; third day, 6 A.M., 10 c.c., 12 M., 40 c.c.; fourth day, 40 c.c.; sixth day, 2 injections of 30 c.c.; seventh day, 30 c.c. Total amount injected, 220 c.c. Death; for 36 hours before death no convulsions—just before death opisthotonos and severe spasm.

Case 33.—**H. B. Williams**, New York Hospital. Age 38. Hand crushed while working in streets. No tetanus bacilli found. Period of incubation, 3 days; mild at first, then very severe; general convulsions; treatment began second day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 20 c.c. at 10 A.M., 12:30 P.M., and 10 P.M. Total amount injected, 60 c.c. Death on second day.

Case 34.—**H. B. Williams**, New York Hospital. Age 13. Punctured wound of foot. No tetanus bacilli found. Period of incubation, 9 days; trismus, retraction and stiffness of neck; treatment began on eighth day; continued 6 days. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, eighth day, 25 c.c.; ninth, 20 c.c.; tenth, 25 c.c.; eleventh, 20 c.c., 25 c.c.; twelfth, 20 c.c.; thirteenth, 20 c.c. Total amount injected, 155 c.c. Gradual improvement; discharged well after 31 days' sickness (27 days after admission).

Case 35.—**J. P. Warbasse**, German Hospital, Brooklyn, N. Y. Age 8. Blank cartridge wound of hand. No tetanus bacilli found. Period of incubation, 6 days; trismus and opisthotonos; T. = 104°; treatment began on first day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum 10 c.c. every 2 hours. Total amount injected, 120 c.c. T.° rose to 108.6° before death on third day. Death.

Case 36.—**J. P. Warbasse**, German Hospital, Brooklyn, N. Y. Age 43. Supravaginal hysterectomy, double oöphorectomy. Incision, 4-5 inches. No tetanus bacilli found. Period of incubation, 6 days; trismus, dysphagia, rigidity of cervical muscles, later opisthotonos; general convulsions; treatment began on first day; continued 1 day. New York City Board of Health's antitoxin used.

Subcutaneous injection of antitoxic serum, 3 injections, q. 8 hours, 20 c.c. Total amount injected, 60 c.c. Death.

CASE 37.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 14. Gunshot wound of foot. No tetanus bacilli found. Period of incubation, 7 days; characteristic; treatment began on first day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 3 injections, 20 c.c. q. 8 hours. Total amount injected, 60 c.c. Death.

CASE 38.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 13. Punctured wound of sole of foot by nail. No tetanus bacilli found. Period of incubation, 4 days; pain in chest, then trismus, pain in neck with rigidity; general convulsions; treatment began on third day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, injections q. 6 hours. How long not stated. Recovery.

CASE 39.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 12. Lacerated wound, hand. No tetanus bacilli found. Characteristic. New York City Board of Health's antitoxin used. Subcutaneous injections of antitoxic serum administered daily, given in injections of 20 c.c. q. 12 hours. Length of period of treatment omitted. Death.

CASE 40.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 10. Blank cartridge wound of right hand. No tetanus bacilli found. Period of incubation, 8 days; slow development; cramp-like pain between scapulæ; then stiffness legs, right arm; trismus. On entering hospital right arm in convulsions. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 6 hours. How long not mentioned. Recovery.

CASE 41.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 28. Punctured wound left foot; nail. No tetanus bacilli found. Period of incubation, 7 days; virulent; stiffness of muscles of neck and face, trismus, involuntary defecation. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, details not furnished. T.° rose to 108.6° before death on third day.

CASE 42.—CHAS. H. GOODRICH, Methodist Episcopal Hospital, Brooklyn, N. Y. Age 23. Right hand lacerated by buzz saw. No tetanus bacilli found. Period of incubation, 14 days; pain in hand, stiffness jaws, neck and abdomen; head retracted; general convulsions; treatment began on third day; continued 3 days. Gibier's antitoxin used. Subcutaneous injection of antitoxic serum third, fourth, and fifth days; 9 doses, 1 q. 8 hours, 8⅓ c.c. Total amount injected, 75 c.c. Serum treatment discontinued as patient grew worse. Death on seventh day.

CASE 43.—CHAS. H. GOODRICH, Methodist Episcopal Hospital, Brooklyn, N. Y. Age 20. Punctured wound of foot from nail. Period of incubation, 6 days; rigidity of jaw; advanced rapidly; pain in back; dysphagia; opisthotonos; general convulsions; treatment began on fourth day; continued 2 days. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, fourth day, 2 injections, 20 c.c. and 12 c.c. Fifth day, 2 injections 20 c.c. each. Total amount injected, 72 c.c. Death on sixth day in sudden and severe convulsions.

CASE 44.—CHAS. H. GOODRICH, Methodist Episcopal Hospital, Brooklyn, N. Y. Age 56. Colectomy for cancer splenic flexure. Anastomosis with bobbin of raw potato. No tetanus bacilli found. Period of incubation, 10 days; eighth day, great abdominal pain; tenth day, choking sensation and dysphagia; trismus and neck rigidity followed; general convulsions; treatment began on first day; continued 2 days. Brooklyn Health Department's antitoxin used. Subcutaneous injection of antitoxic serum, first day, in evening, 20 c.c.; second day, A.M., 20 c.c.; P.M., 30 c.c. Total amount injected, 70 c.c. Death during tenth severe general convulsion on second day.

CASE 45.—HALL AND CLOPTON, St. Louis; private. Age 55. Penetrating wound of sole of right foot. No tetanus bacilli found. Period of incubation, 13 days; spasms in right leg extending up into thigh; next, trismus with dysphagia; symptoms of mild type; treatment began on first day; continued 10 days.

Subcutaneous injection of antitoxic serum, 1 injection of 10 c.c. daily for 10 days. Total amount injected, 1000 c.c. Wound excised first day. Disease lasted 12 days. Mild. Recovery.

CASE 46.—J. C. MORFIT, St. Louis; private. Age 30. Penetrating wound of toe; rusty nail. No tetanus bacilli found. Period of incubation, 7 days; severe; extreme trismus; treatment began on first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 1 injection, "large amount." Very severe case. Death on first day.

CASE 47.—J. C. MORFIT, Mullanphy Hospital, St. Louis. Age 19. Gunshot wound left hand. Had intercurrent tonsillitis. Tetanus bacilli found. Period of incubation, 11 days; risus sardonicus, dysphagia, stiffness of neck, abdomen and extremities; opisthotonos; general convulsions; treatment began on first day; continued 10 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 6 injections; second day, 3; third day, 2; fourth day, 2; fifth to tenth days, 1 daily, all of 10 c.c. Total amount injected, 100 c.c. Recovery. "I have seen a more severe case recover without any treatment."

CASE 48.—WM. J. TAYLOR, St. Agnes Hospital, Philadelphia. Age 8. Punctured wound (healed) in palm of hand; nail. No tetanus bacilli found. Period of incubation, 6 days; entered hospital second day; stiffness of neck and back, trismus, marked convulsions, opisthotonos, risus sardonicus; general convulsions; treatment began on first day; continued 1 day. Subcutaneous injection of antitoxic serum, first day, 30 c.c. about noon. Total amount injected 30 c.c. Discharged cured on third day.

CASE 49.—JAS. TYSON, Pennsylvania Hospital, Philadelphia. Age 53. Healed punctured wound plantar surface right foot. No tetanus bacilli found. Period of incubation, 9 days; trismus, rigidity of cervical muscles and those of jaw, back and abdomen; admitted fifth day; treatment began on fifth day; continued 1 day. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c. given about wound, and 30 c.c. and later 60 c.c. into abdomen. Total amount injected, 120 c.c. Death 24 hours after admission.

CASE 50.—ALFRED STENGEL Pennsylvania Hospital, Philadelphia. Age 27. Burn of arm (coal oil). No tetanus bacilli found. Period of incubation, 25 days; admitted 30 days after injury; profound trismus; slightest noise would produce general convulsions with opisthotonos; general convulsions; treatment began fifth day; continued 1 day. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 3 injections 40 c.c. each; 9 A.M., 12 M. and 4 P.M. Total amount injected, 120 c.c. After 3 doses, carbolic acid injections given. Gradual recovery. Well in 25 days.

CASE 51.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore. Age 52. Punctured wound sole of foot, rusty nail. Period of incubation, 7 days; admitted second day; stiffness neck and jaws; almost absolute trismus; risus sardonicus; rigid abdominal muscles; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 30 c.c. injected into axilla and 20 c.c., summary. Total amount injected, 50 c.c. Death on day of admission.

CASE 52.—C. A. PORTER, Massachusetts General Hospital. Age 55. Compound fracture right ankle. Leg amputated day before first symptoms. Period of incubation, 6 days; rigid neck; T. 105°; dysphagia; no general convulsions; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 20 c.c. q. 4 hours. Death on third day.

CASE 53.—C. A. PORTER, Massachusetts General Hospital. Age 20. Multiple lacerated dynamite wounds from knee to jaw right side of body. No tetanus bacilli found. Period of incubation, 7 days; dysphagia, rapid increase in severity; T. 100.2°, P. 68, R. 22; treatment began on first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum 20 c.c. q. 4 hours. Total amount injected, 80 c.c. Death in 17 hours.

CASE 54.—C. A. PORTER, Massachusetts General Hospital. Age 16. Blank cartridge wound of finger. Period of incubation, 6 days; opisthotonos, diaphragmatic breathing, trismus, dysphagia; T. 100.4°, P. 124, R. 22; treatment began second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c. in pectoral region repeated in 6 hours and again in 4 hours. Total amount injected, 90 c.c. Death in 18 hours.

Case 55.—C. A. Porter, Massachusetts General Hospital. Age 11. Blank cartridge wound of palm. Tetanus bacilli found. Period of incubation, 9 days; slight risus, slight retraction of head; T. 100.5°, P. 84; treatment began on second day; continued 4 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours increasing to 20 c.c. q. 2 hours on last day. Death on sixth day.

Case 56.—C. A. Porter, Massachusetts General Hospital. Age 36. Blank cartridge wound left hand. No tetanus bacilli found. Period of incubation, 7 days; masseters, neck and abdominal muscles stiff; T. 99.8°, P. 70, R. 28; treatment began on second day; continued 2 days. Subcutaneous injection of antitoxic serum, 20 c.c. q. 4 hours. Doubled amount on second day. Death on third day.

Case 57.—C. A. Porter, Massachusetts General Hospital. Age 10. Blank cartridge wound left side thorax. No tetanus bacilli found. Period of incubation, 7 days; convulsions; no lung symptoms or dyspnœa; T. 102°, P. 150, R. 35; general convulsions; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 5 c.c., 15c.c., 20 c.c. q. 3 hours. Death on second day.

Case 58.—C. A. Porter, Massachusetts General Hospital. Age 11. Blank cartridge wound, left palm. Tetanus bacilli found. Period of incubation, 7 days; trismus and dysphagia; T. 99.8°, P. 92, R. 18; treatment began on second day; continued 3 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 40 c.c. on entrance, 10 c.c. q. 3 hours. Death on fourth day. T. 108°.

Case 59.—C. A. Porter, Massachusetts General Hospital. Age 13. Compound fracture of forearm. No tetanus bacilli found. Period of incubation, 7 days; very severe; T. 104.8°, P. 140, R. 27; general convulsions every 20 seconds; treatment began on second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c. after amputation of arm, 20 c.c. 6 hours later. Total amount injected, 50 c.c. Death in 23 hours.

Case 60.—C. A. Porter, Massachusetts General Hospital. Age 27. Punctured wound foot; nail. No tetanus bacilli found. Period of incubation, 14 days; mild at first, gradually increasing; T. 104°, P. 72, R. 23; no general convulsions; treatment began on second day. Subcutaneous injection of antitoxic serum, 20 c.c. q. 6 hours. Gradual recovery in 23 days.

Case 61.—C. A. Porter, Massachusetts General Hospital. Age 9. Blank cartridge wound, hand. No tetanus bacilli found. Period of incubation, 10 days; trismus, spasms of flexors of hand, opisthotonos on stimulation; T. 100.6°, P. 112, R. 25; general convulsions; treatment began on second day; continued 4 days. Subcutaneous injection of antitoxic serum, every 4 hours for 4 days in varying amounts. Discharged after 33 days.

Case 62.—C. A. Porter, Massachusetts General Hospital. Age 28. Blank cartridge wound, left hand. Period of incubation, 7th day; trismus and rigidity muscles neck and abdomen; T. 100°, P. 80, R. 22; no general convulsions. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours. Recovery in 26 days. Never had convulsions.

Case 63.—James Bell, Royal Victoria Hospital, Montreal. Age 29. Punctured wound of sole of foot; rusty nail. Period of incubation, 6 days; stiffness of jaw and back muscles; jolting caused spasms; later, spasms of muscles of abdomen and extremities; risus sardonicus; general convulsions; treatment began on fifth day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 10 c.c. subcutaneously; second day, 10 c.c. subcutaneously. Total amount injected, 20 c.c. Death on seventh day.

Case 64.—James Bell, Royal Victoria Hospital, Montreal. Age 18. Punctured wound of foot; nail. Period of incubation, 8 days; stiffness of jaw, dysphagia, constricted feeling in chest; treatment began on fifth day; continued 6 days. Gibier's and Roux's antitoxin used. Subcutaneous injection of antitoxic serum, sixth day: 11:30 A.M., 1 c.c.; 5:30 P.M., 1 c.c. Seventh day: 11 A.M., 1 c.c.; 6 P.M., 10 c.c. Eighth day: 6 A.M., 10 c.c.; 12 M., 25 c.c.; 6 P.M., 25 c.c. Ninth day: 12 P.M., 25 c.c.; 6 A.M., 25 c.c.; 12 M., 10 c.c. Tenth day: 12 P.M., 10 c.c.; 12 M., 25 c.c.; 6 P.M., 25 c.c. Eleventh day: 12 P.M., 85 c.c. Total amount injected, 278 c.c. Death on eleventh day.

Case 65.—James Bell, Royal Victoria Hospital, Montreal. Age 42. Compound fracture tibia and fibula left leg. Tetanus bacilli found. Period of incubation, 10 days; stiffness of jaws, dysphagia, risus sardonicus, rigidity of abdominal muscles, rectal tenesmus, spasms of muscles of face; treatment began on second day; continued 19 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, second day: 3 P.M., 30 c.c.; 11 P.M., 20 c.c. Third to eighth days, 20 c.c. daily; ninth day, 10 c.c.; fifteenth day, 20 c.c.; eighteenth day, 20 c.c.; twenty-first day, 20 c.c. Total amount injected, 240 c.c. Recovery in 44 days.

Case 66.—James Bell, Royal Victoria Hospital, Montreal. Slight superficial cut on palm of left hand. No tetanus bacilli found. Period of incubation, 12 days; dysphagia, face swollen, backache, constricted feeling in chest, opisthotonos; injured hand flexed at wrist, thumb adducted; general convulsions; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 10 c.c. into wound and 20 c.c. into right loin on admission; 12 M., 40 c.c. into left loin. Total amount injected, 70 c.c. Recovery.

CASES OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM INJECTED INTO VARIOUS STRUCTURES.

Case 1.—Roswell Park, Buffalo General Hospital. Age 10. A punctured wound of sole of foot, by tack. Period of incubation, 8 days; marked tetanus and opisthotonos; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 30 c.c., at 7 P.M.; 23 c.c., 11 P.M. Intraneural injection, 3 c.c., into sciatic; 3 c.c., into anterior crural. Intraspinal injection at two places, each 12 c.c. Total amount injected, 83 c.c. Death one-half hour after second injection.

Case 2.—Geo. T. Vaughan, Emergency Hospital, Washington, D. C. Age 25. Thumb and two fingers destroyed by burn. Dressed with ichthyol and iodoform. Period of incubation, 16 days; trismus, abdominal rigidity, opisthotonos; general convulsions; treatment began first day; continued 4 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 20 c.c. q. 4 hours for first 2 days. Intravenous injection, 1st day 10 c.c. Intracranial, 3rd and 4th days 30 c.c. daily under dura. Total amount injected, 310 c.c. Death on 4th day.

Case 3.—H. B. Gessner, Charity Hospital, New Orleans, La. Age 18. Railroad injury to right foot and laceration of the scalp. Period of incubation, 11 days; severe; temperature, 102°; general convulsions; treatment began on second day; continued one day. P. D. & Co's. antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. into foot. Intraspinal, 162 m. Total amount injected, 21 c.c. Convulsions disappeared in 10 days, cured in 34 days.

Case 4.—S. Logan, Charity Hospital, New Orleans, La.; service Dr. Matas. Age 13. Toy pistol wound on right hand. Period of incubation, 8 days; mild, slight opisthotonos, few convulsions; general convulsions; treatment began on first day; continued 3 days. P. D. & Co's. antitoxin used. Intraneural injection, perineural 50 c.c. Intraspinal injection, 10 c.c. Total amount injected, 60 c.c. Course and termination not stated.

Case 5.—C. B. G. de Nancrede; private patient. Age 18. Severe injury of foot. Early manifestations of tetanus not stated. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours. Intraneural injection, at time of amputation into severed nerve trunks; intraspinal injection, at time of amputation. Amputation through middle of leg. Recovery.

CASE 6.—PATCH, Montreal General Hospital. Age 5. Traumatic amputation of thigh; bone and muscles protruding. No tetanus bacilli found. Period of incubation, 9 days; admitted second day unconscious, trismus, opisthotonos; T. 99.2°–104.4°; general convulsions, 2; treatment began second day; continued 1 hour. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. Intraspinal injection, 20 c.c. Intracranial, 10 c.c. Total amount injected, 40 c.c. Death 1 hour after injections.

CASE 7.—PATCH, Montreal General Hospital. Age 16. Laceration of forehead. Period of incubation, 8 days; trismus and dysphagia gradually increasing for 6 days; on admission spastic gait, head retracted to left, trismus, paralysis of tongue, respiratory distress, rt. facial paralysis; treatment began on sixth day; continued 2 days. Roux's antitoxin used. Subcutaneous injection of antitoxic serum, 5 c.c. on sixth day. Intraspinal injection, sixth day, 10 c.c.; seventh day, 15 c.c. Total amount injected, 30 c.c. Improvement began 4 days after admission. Up 10 days later. Recovery.

CASE 8.—PATCH, Montreal General Hospital. Age 5. Small wound on sole of foot, healed, enclosing drop pus. No tetanus baccilli found. Period of incubation, 10 to 14 days; stiffness neck and arms in morning; 10 P.M., general convulsions, opisthotonos; next day trismus, twitching face, all muscles in tonic convulsions, T. 98°; general convulsions; treatment began second day; continued 15 hours. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. first; intraspinal injection later, 10 c.c. Total amount injected, 20 c.c. Death 15 hours after first injection. T.° 109°.

CASE 9.—WM. M. MASTIN, Mobile City Hospital, Mobile, Ala. Age 35. Following abortion. No tetanus bacilli found. Period of incubation, 7 to 8 days; mild trismus, muscular rigidity, opisthotonos; general convulsions; treatment began on second day; continued 5 days. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, third to sixth days, 20 c.c. q. 4 to 8 hours. Intraspinal injection, second day, 20 c.c. Total amount injected, 400 c.c. Morphine and chloral also given. Recovery.

CASE 10.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland. Age 26. Blank cartridge wound, hand; healing. No tetanus bacilli found. Period of incubation, 7 days; trismus; during next 48 hours muscles of neck, back and legs rigid; treatment began first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 5 c.c. Intracranial, 2½ c.c. into each lateral ventricle. Total amount injected, 10 c.c. T. rose from 100° to 109° (axillary). Death on fourth day.

CASE 11.—DUDLEY TAIT, French Hospital, San Francisco. Age 27. Slight abrasion received in cleaning hides. No tetanus bacilli found. Period of incubation, 6 days; acute, characteristic symptoms; entered hospital second day; treatment began second day; continued 3 days. P. D. & Co.'s antitoxin used. Intravenous injection, several of 8 c.c. on third day. Intracranial injection, second day, 1 and 1½ c.c. in each frontal lobe. Death on fourth day.

CASE 12.—DUDLEY TAIT, San Francisco; private patient. Age 26. Lacerated wound left index finger. Period of incubation, 14 days; subacute; general convulsions; treatment began on first day; continued 5 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day 4 injections, 20 c.c., afterwards 2 injections daily. Intravenous injection, first day, 4 injections 1½ c.c., afterwards 2 daily. Total amount injected, 36 c.c. Death.

CASE 13.—DUDLEY TAIT, San Francisco; private patient. Age 30. Wound, right hand (stable man). No tetanus bacilli found. Period of incubation, 10 days; mild; general convulsions; treatment began first day; continued few days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 2 injections first day, repeated daily. Intravenous injection, 2 injections first day, repeated daily. Recovery.

CASE 14.—GEO. E. BREWER, Roosevelt Hospital, New York City. Age 14. Blank cartridge wound base of left forefinger. No tetanus bacilli found. Period of incubation, 6 days; severe trismus; head retracted; general convulsions with opisthotonos and spasms of extremities; general convulsions; treatment began first day; continued 2 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 20 c.c. Intravenous injection, second day, 20 c.c. Total amount injected, 40 c.c. Death second day.

Case 15.—Geo. E. Brewer, Roosevelt Hospital, New York City. Age 21. Infected blank cartridge wound base left forefinger. No tetanus bacilli found. Period of incubation, 8 days; some trismus, stiffness back of neck, painful dysphagia, opisthotonos; general convulsions; treatment began second day; continued 10 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, second day, 4 doses; third day, 6 doses; fourth day, 2 doses; fifth day, 2 doses; sixth day, 3 doses; seventh day, 4 doses; eighth day, 3 doses; ninth day, 4 doses; tenth day, 3 doses; each 20 c.c. Intravenous injection, fifth day, 4 doses 20 c.c. Total amount injected, 640 c.c. Dyspnœa and cyanosis third day with dysphagia and strangling. No symptoms until seventh day. Then rigidity of muscles. Later became comfortable. Death twelfth day.

Case 16.—Geo. E. Brewer, Roosevelt Hospital, New York City. Age 24. Compound fracture ulna with lacerated elbow. No tetanus bacilli found. Period of incubation, 7 days; trismus, pain back of neck, opisthotonos, involuntary micturition; treatment began first day; continued 2 days. Subcutaneous injection of antitoxin serum, first day, 60 c.c. Intravenous injection, first day, 40 c.c. with 1,000 c.c. saline solution; same second day. Total amount injected, 140 c.c. Death on second day.

Case 17.—Henry Heiman, Mt. Sinai Hospital, New York. Age 12. Penetrating wound right foot; nail. Tetanus bacilli found. Period of incubation, 11 days; severe rigidity, neck, back and legs; trismus, hyperacusis; treatment began third day; continued 8 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 8 injections, 20 c.c. Intraspinal injection, 3 injections of 20 c.c. Total amount injected, 220 c.c. Recovery. Question if due to serum.

Case 18.—A. V. Moschcowitz, Mt. Sinai Hospital, New York. Age 18. Blank cartridge, palm hand. No tetanus bacilli found. Period of incubation, 7 days; mild at first, increasing in severity; treatment began second day; continued 2 days. Antitoxin of Institute Pasteur, Paris, used. Intravenous injection, second day, 2 injections of 20 c.c. and 10 c.c. Intracranial injection, third day, 5 c.c. Total amount injected, 35 c.c. Death.

Case 19.—Willy Meyer, German Hospital, New York. Age 27. Appendectomy through rectus muscle. No tetanus bacilli found. Period of incubation, 10 days; trismus, pain in muscles of jaw; rigidity and pain in muscles of neck, risus sardonicus, opisthotonos, dysphagia; treatment began second day; continued 6 days. Subcutaneous injection of antitoxic serum, third day, 10 c.c.; seventh and eighth days, 10 c.c.; ninth day, 15 c.c. Intraspinal injection, second day, 2½ c.c.; third day, 10 c.c.; fifth day, 12 c.c. and 15 c.c. Total amount injected, 84½ c.c. Gradual recovery.

Case 20.—Fred Kammerer, German Hospital, New York. Age 38. Appendectomy during quiescent period. Primary incision. Tetanus bacilli found. Period of incubation, 9 days; very severe, risus sardonicus, rigidity muscles neck, abdomen; later paralysis muscles deglutition, rigidity of intercostals; general convulsions; treatment began first day; continued 11 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 30 c.c.; sixth, seventh, eighth, ninth, tenth, eleventh days, 2 injections of 30 c.c. Intraspinal injection, second day, 15 c.c. Intravenous injection, third, fourth and fifth days, each, 30 c.c. Total amount injected, 495 c.c. Improvement for 9 days, then increase in symptoms. Death twelfth day.

Case 21.—H. B. Williams, Hudson St. House of Relief, N. Y. City. Age 12. Blank cartridge wound left thigh; suppurating; 4th July, 1899. Period of incubation, 4 days; stiffness of thigh, 5 days later trismus, risus sardonicus, opisthotonos; general convulsions; treatment began seventh day; continued 1 day. Subcutaneous injection of antitoxic serum, seventh day, 20 c.c. Intracranial injection, seventh day, 5 c.c. into each frontal lobe. Total amount injected, 30 c.c. Death on eighth day.

Case 22.—H. B. Williams, Hudson St. House of Relief, N. Y. City. Age 13. Blank cartridge wound base of left thumb. Dressed 5 hours after injury; no subsequent dressing. Period of incubation, 5 days; sudden stiffness jaw, next day mild opisthotonos and marked trismus; general convulsions; treatment began second day; continued 1 day. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 50 c.c. Intracranial injection, 10 c.c. into each lateral ventricle. Total amount injected, 70 c.c. Death on third day.

Case 23.—H. B. Williams, New York Hospital. Age 54. Compound fracture of leg. Amputated at hospital 6 days later. No tetanus bacilli found. Period of incubation, 9 days; trismus; treatment began first day; continued 1 day. N. Y. C. B. of H.'s antitoxin used. Intravenous injection, 20 c.c. in 450 c.c. salt solution. Intracranial injection into each lateral ventricle. Total amount injected, 20 c.c. +. Death on second day. Leg amputated 6 days after injury.

Case 24.—H. B. Williams, New York Hospital. Age 17. Blank cartridge wound palm right hand. No tetanus bacilli found. Period of incubation, 6 days; trismus and mild risus sardonicus; treatment began second day; continued 11 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, second day, into chest and abdomen, 20 c.c.; fourth day, q. 6 hours, 20 c.c., 10 c.c., 20 c.c.; fifth day, 20 c.c. Intraspinal injection, sixth to twelfth days inclusive, daily 20 c.c. Intravenous injection, third day, 50 c.c. Total amount injected, 200 c.c. Death on twelfth day.

Case 25.—R. R. Canna, King's County Hospital, Brooklyn. Age 40. Rusty nail from stable into foot. No trouble locally with wound. Tetanus bacilli found. Period of incubation, 4 days; entered hospital seventh day, trismus had been present 3 days, opisthotonos; general convulsions; treatment began fourth day; continued 1 day. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 20 c.c. Intraspinal injection, 40 c.c. Total amount injected, 60 c.c. Foot amputated; death in coma day after admission.

Case 26.—R. R. Canna, King's County Hospital, Brooklyn. Age 22. R. R. traumatic amputation right thigh. Tetanus bacilli found. Period of incubation, 8 days; difficulty in opening mouth; trismus followed delirium; opisthotonos; treatment began first day; continued 15 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 40 c.c. first day. Intraspinal injection, 15 c.c., first day; 20 c.c. each day subsequently until death. Total amount injected, 335 c.c. Death on fifteenth day.

Case 27.—Geo. Pickerell, U. S. N., U. S. Naval Hospital, San Juan, Porto Rico. Age 22. Punctured wound inner side right leg, just below knee. Period of incubation, 10 days; ninth day coryza with soreness and stiffness of jaws; tenth day symptoms marked; eleventh day pronounced trismus, on auscultation murmur over muscles jaw, neck and chest; general convulsions, eleventh day, 1 of fifteen minutes, thirteenth day, 3; treatment began second day; continued 6 days. "French" antitoxin used. Subcutaneous injection of antitoxic serum, second day, 10 c.c.; third day, 20 c.c.; fourth, fifth, sixth, each 20 c.c. Intracranial injection, third day right lateral ventricle and subdural, each 3 c.c. Total amount injected, 100 c.c. After fourth day gradual improvement. Recovery 55 days after injury.

Case 28.—J. B. Carnett, Philadelphia Hospital. Age 9. Nail perforated shoe; punctured wound of sole. No tetanus bacilli found. Period of incubation, 6 days; admitted second day; trismus 24 hours' duration; general convulsions 12 hours before; general spastic condition of muscles; general convulsions; treatment began second day; continued few hours. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c. Intraneural injection, 30 c.c. into great sciatic at gluteal fold. Intraspinal injection, 35 c.c. Total amount injected, 95 c.c. Given at one time under anæsthetic. Death 3 hours later.

CASE 29.—JAS. TYSON, Pennsylvania Hospital, Philadelphia. Age 27. No wound except that of tongue bitten during first convulsion 4 days before. Retained placenta found at autopsy. No tetanus bacilli found. On admission, trismus, general muscular rigidity, increased reflexes; general convulsions; treatment began fourth day; continued 1 day. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c., later, 20 c.c. Intraspinal injection, 20 c.c., later, 30 c.c. Total amount injected, 80 c.c. Death 24 hours after admission into hospital.

CASE 30.—JAS. TYSON, Pennsylvania Hospital, Philadelphia. Age 26. Small punctured wound right foot; rusty nail. No tetanus bacilli found. Period of incubation, 6 days; only painful mastication; reflexes increased; seventh day, general muscular rigidity; ninth day, convulsions; general convulsions; treatment began first day; continued 2 days. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, first day, 30 c.c. over sciatic nerve; later, again, 30 c.c.; second day, q. 4 hours 60 c.c. Intraspinal injection, first day, 30 c.c. Total amount injected, 420 c.c. Death on third day.

CASE 31.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 43. Punctured wound left great toe; rusty nail. Tetanus bacilli found. Period of incubation, 8 days; stiffness muscles jaw and neck; progressed rapidly to opisthotonos; general convulsions; treatment began second day; continued 5 days. Subcutaneous injection of antitoxic serum deep into thigh muscles twice daily for several days, 10 c.c. Intracranial injection, once, 5 c.c. into each frontal lobe. Total amount injected, 90 c.c. Death on seventh day.

CASE 32.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 50. Gangrene right foot from frost bite; amputation. No tetanus bacilli found. Five days after admission retraction head; 2 hours later opisthotonos, risus sardonicus; 3 hours later general convulsions; injection of antitoxic serum, 5 c.c. into thigh muscles first day and 15 c.c. second day, 5 c.c. under skin. Intravenous injection, 10 c.c. second day. Total amount injected, 35 c.c. Death on second day.

CASE 33.—NATHAN JACOBSON, St. Joseph's Hospital, Syracuse, N. Y. Blank cartridge wound right hand July 4th, 1899. Wound opened on admission to hospital and wad removed. No tetanus bacilli found. Period of incubation, 7 days; admitted on fourth day with trismus, stiffness neck muscles and general convulsions; general convulsions; treatment began fourth day; continued 2 days. Subcutaneous injection of antitoxic serum, fourth day, 2 injections, 10 c.c. Intracranial injection, fifth day, twice, 10 c.c. Total amount injected, 40 c.c. Death, 7 A.M on sixth day.

CASE 34.—H. B. WILLIAMS, Hudson St. House of Relief, N. Y. City. Age 22. Punctured wound left foot; rusty nail. No tetanus bacilli found. Period of incubation, 5 days; stiffness of neck and jaw muscles; treatment began fifth day; continued 1 day. N. Y. City Health Department's antitoxin used. Subcutaneous injection of antitoxic serum, 1 injection, 10 c.c. Intraspinal injection, 1 injection 10 c.c. Total amount injected, 20 c.c. Death on sixth day of disease; one day after admission.

CASE 35.—C. A. PORTER, Massachusetts General Hospital. Age 13. Blank cartridge wound, left palm. Tetanus bacilli found. Period of incubation, 4 days; pain in back of neck, trismus; risus sardonicus; convulsions; general convulsions; treatment began on fourth day; continued 1 day. P. D. & Co.'s antitoxin used. Intraneural injection, median and ulnar at wrist, 1 c.c.-3 c.c. Intraspinal injection, 11 c.c. twice. Total amount injected, 26 c.c. Death 16 hours after admission.

CASE 36.—C. A. PORTER, Massachusetts General Hospital. Age 10. Cannon cracker wound, right arm. Tetanus bacilli found. Period of incubation, 4 days; trismus, convulsions, dysphagia; T. 100.2°, P. 110, R. 30; general convulsions; treatment began second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection about wound. Intraneural injection into roots of brachial plexus. Death 16 hours after admission.

CASE 37.—C. A. PORTER, Massachusetts General Hospital. Age 15. Blank cartridge wound, right palm. Tetanus bacilli found. Period of incubation, 7 days; admitted second day; trismus, risus sardonicus, convulsions, pain in neck and abdomen, diaphragmatic breathing; general convulsions; treatment began second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum every 4 hours. Intraneural injection, median and ulnar at wrist, 4½ c.c. each. Intraspinal injection every 6 hours. Death 17 hours after admission.

CASE 38.—C. A. PORTER, Massachusetts General Hospital. Age 17. Knife cut second and third fingers. Period of incubation, 3 weeks; stiffness in jaws and neck, pain in back; T. 102.2°, P. 90; general convulsions; treatment began on second day; continued 1 day. Intraneural injection into brachial plexus, 5 c.c. Intraspinal injection, 10 c.c. Total amount injected, 15 c.c. Death on third day.

CASE 39.—C. A. PORTER, Massachusetts General Hospital. Age 17. Wound right leg, cannon cracker. Tetanus bacilli found. Period of incubation, 7 days; general slight rigidity, marked trismus; T. 101°, P. 96, R. 28; treatment began third day; continued 2 days. P. D. & Co.'s and Massachusetts State B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 20 c.c. Intravenous injection, 30 c.c. in salt solution; 50 c.c. q. 6 hours, second day. Total amount injected, 200 c.c. Death 48 hours after admission.

CASE 40.—C. A. PORTER, Massachusetts General Hospital. Age 17. Blank cartridge wound of hand. Tetanus bacilli found. Period of incubation, 7 days; severe general convulsions; T. 102.8°, P. 152, R. 28; general convulsions; treatment began on first day; continued 2 hours. Subcutaneous injection of antitoxic serum, 10 c.c. Intracranial injection, 3 c.c., into each lateral ventricle. Total amount injected, 16 c.c. Death in 2½ hours.

CASE 41.—C. A. PORTER, Massachusetts General Hospital. Age 33. Punctured wound of foot; nail. No tetanus bacilli found. Period of incubation, 5 days; trismus, moderate degree; T. 99.2°, P. 88, R. 22; general convulsions; treatment continued 3 days. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours. Intracranial injection, 3 c.c., into each lateral ventricle, second day. Total amount injected, 186 c.c. Death 72 hours after admission.

CASE 42.—C. A. PORTER, Massachusetts General Hospital. Age 73. Frozen toe. No tetanus bacilli found. Period of incubation, 2 weeks; trismus, risus sardonicus; general convulsions; treatment began first day; continued 8 hours. Pasteur Institute antitoxin used. Intravenous injection, 40 c.c., twice. Intracranial injection, 3 c.c. into each frontal lobe and 2 c.c. under dura. Total amount injected, 90 c.c. Death 8 hours after admission.

CASE 43.—C. A. PORTER, Massachusetts General Hospital. Age 56. Nail wound, right heel. Period of incubation, 2 weeks; risus and tense abdomen; no general convulsions; treatment began fourth day. Subcutaneous injection of antitoxic serum, 20 c.c. Intraneural injection, 1 c.c. into anterior crural and sciatic. Death on fifteenth day. Not due to tetanus but to bed sores, etc.

CASE 44.—C. A. PORTER, Massachusetts General Hospital. Age 18. Machine crushed second and third fingers. Tetanus bacilli found. Period of incubation, 13 days; trismus; pain in abdomen; T. 101.6°, P. 90, R. 24; general convulsions; treatment began second day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 12 hours. Intraneural injection, musculospiral, median, and ulnar nerves injected, 10 c.c. each. Intraspinal injection, 10 c.c. twice. Total amount injected, 60 c.c. +. Recovery. Discharged thirtieth day.

CASE 45.—W. J. ROE, Jefferson Medical College Hospital. Age 14. Appendectomy during quiescent period. No tetanus bacilli found. Period of incubation, 9 days; dull pain in head and neck, trismus, retraction of head, risus sardonicus, opisthotonos, dysphagia, tonic rigidity muscles of abdomen and extremities; general convulsions; treatment began first day; continued 6 days. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 1230 c.c. Intraspinal injection, 175 c.c. antitoxin and 13 c.c. of a 25 per cent.

$MgSO_4$ solution. Intravenous injection, 90 c.c. Total amount injected, 1495 c.c. Death.

CASE 46.—JAMES BELL, Royal Victoria Hospital, Montreal. Lacerated wrist; glass. Tetanus bacilli found. Period of incubation, 11 days; stiffness and numbness in fingers of injured arm; next day, trismus; fingers flexed into palm; treatment began first day; continued 18 days. Subcutaneous injection of antitoxic serum, first, second and third days, 20 c.c.; fourth to seventh days, 60 c.c. daily. Intraspinal injection, seventeenth day, 10 c.c.; eighteenth day, 10 c.c. Total amount injected, 320 c.c. Recovery in 31 days.

CASE 47.—JAMES BELL, Royal Victoria Hospital, Montreal. Age 9. Contusion and laceration of skin over tibia. Tetanus bacilli found. Period of incubation, 47 days; sore tongue, weak, backache, spastic condition lower extremities and retraction of head; general convulsions; treatment began *first day after injury,* 4 days after first symptoms; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 5 c.c. *first day after injury as a prophylactic;* fourth day of disease, 10 c.c. Intraneural injection, 7 c.c. into anterior crural. Intraspinal injection, 7 c.c. Total amount injected, 29 c.c. Death on fifth day.

CASE 48.—JAMES BELL, Royal Victoria Hospital, Montreal. Age 5. Infected vaccination wound. Tetanus bacilli found. Period of incubation, 23 days; stiffness arm and jaw, neck stiff, painful, sternomastoid contracted (operation), opisthotonos, numerous spasms; general convulsions; treatment began first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c., 4 c.c., 10 c.c. Intraneural injection, 4 c.c. into sheath of musculo-spiral, musculo-cutaneous, and ulnar; enough to swell median 3 times its natural size was injected. Intraspinal injection, 4 c.c.; later, 4 c.c. by cervical puncture; still later, 10 c.c. as above. Intravenous injection, 4 c.c. Total amount injected, 58 c.c. +. Death on second day.

CASES OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS ADMINISTERED BY INTRASPINAL INJECTION WITH ANTITOXIC SERUM.

CASE 1.—R. MATAS, New Orleans; private patient. Age 24. Vaccination. Period of incubation, 17 days; severe tonic spasm of all voluntary and respiratory muscles; treatment began first day. P. D. & Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, 50 c.c. Total amount injected, 50 c.c. Result not stated.

CASE 2.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 10. Lacerated wound left heel; cut with glass 4 weeks before admission, nearly healed. Period of incubation, 26 days; trismus, neck arched, opisthotonos; hypersensitive; general convulsions; treatment began third day; continued 12 days. P. D. & Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, 10 c.c. q. 6 hours for 5 days; 10 c.c. q. 8 hours for 1 day; 10 c.c. once daily for 6 days. Total amount injected, 290 c.c. Left hospital in 4 weeks, well.

CASE 3.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 9. Boy running barefoot, number scratches and cuts on feet. Tonic convulsions, head thrown back, opisthotonos, extremities rigid; general convulsions; treatment began first day; continued 5 days. P. D. & Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, 10 c.c. q. 8 hours. Total amount injected, 150 c.c. Death on fifth day.

CASE 4.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 14. Small punctured wound right foot; nail. No tetanus bacilli found. Period of incubation, 8 days; trismus, opisthotonos, extremities rigid; treatment began first day; continued 36 hours. P. D. &. Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, 10 c.c. q. 6 hours. Total amount injected, 50 c.c. Death in 36 hours.

CASE 5.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 34. Three unclean wounds left hand; present 3 to 4 weeks. No tetanus bacilli found. Period of incubation, 21 days; 5 days before admission, pain in back and dizziness; 3 days before, pain and stiffness of back, trismus; day before, convulsions, opisthotonos, risus sardonicus; general convulsions; treatment began third day; continued 11 days. P. D. & Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, 10 c.c. q. 6 hours for 6 days, 240 c.c.; 10 c.c. once daily for 5 days, 50 c.c. Total amount injected, 290 c.c. Recovering.

CASE 6.—WALLACE I. TERRY, San Francisco City and County Hospital. Age 32. Punctured wound outer side plantar aspect right foot; nail. No tetanus bacilli found. Period of incubation, 7 days; stiffness neck and trismus, general convulsions, first day, opisthotonos; general convulsions; treatment began on first day; continued 4 days. P. D. & Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, first day, 90 c.c.; second day, 30 c.c.; third day, 20 c.c.; fourth day, 10½ c.c. Total amount injected, 150½ c.c. Death on fourth day.

CASE 7.—WILLY MEYER, German Hospital, N. Y. City. Age 37. Superficial wound over right parietal; fell from elevated railroad. Immediate suture, suppuration, reopened. Period of incubation, 5 days; trismus; 4 days later tetanus; general convulsions; treatment began on seventh day; continued 1 day. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, single injection, 10 c.c. Total amount injected, 10 c.c. Death next day.

CASE 8.—W. H. LUCKETT, Harlem Hospital, N. Y. City. Age 12. Blank cartridge wound right hand, July 4th. No tetanus bacilli found. Period of incubation, 7 days; stiffness in jaw, pain back neck, and right side chest; hand with claw-like contraction digits, abdominal muscles rigid; treatment began on second day; continued 12 days. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, second day, 8 c.c.; third day, 11 c.c.; fourth day, 12 c.c.; fifth day, 10 c.c.; sixth day, 12 c.c.; seventh day, 12 c.c.; eighth day, 15 c.c.; thirteenth day, 15 c.c. Spinal fluid withdrawn on second day, 22 m.; third day, 12 m.; fourth day, 5 m.; fifth day, 40 m.; sixth day, 2 m.; seventh day, 35 m.; eighth day, 45 m. Total, 161 m. withdrawn. Total amount injected, 92 c.c. Fifteenth day sat up in bed. Seventeenth day out of bed. Eighteenth day opened mouth. Nineteenth day discharged cured. 161 m. Cerebrospinal fluid withdrawn.

CASE 9.—W. H. LUCKETT, Harlem Hospital, N. Y. City. Age 10. Left wrist cut on broken bottle while vaulting garden fence. Period of incubation, 5 days; on fifth day abdominal pain with tonic contraction muscles; treatment began second day; continued 5 days. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, once daily for 5 days, 9 c.c.–14 c.c. at a dose, first withdrawing cerebrospinal fluid. Total amount of spinal fluid withdrawn, 605 m. Total amount injected, 59 c.c. Sat up thirteenth day. Discharged well seventeenth day.

CASE 10.—W. H. LUCKETT, Harlem Hospital, N. Y. City. Age 17. Blank cartridge wound, palmar surface right hand, July 4th. Period of incubation, 8 days; severe pain in head, dyspnœa, inability to articulate, muscular twitchings, trismus, rigid intercostals, abdomen rigid, left hand claw-like, contraction fingers, opisthotonos marked; general convulsions, 10; treatment began on second day; continued 4 days. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, once daily, each time preceded by withdrawal of cerebrospinal fluid, amounting in all to 1550 m. Injections each 18 c.c.–20 c.c. Total amount injected, 78 c.c. Gradual improvement, stiffness of legs last to disappear. Recovery in 1 month.

CASE 11.—W. H. LUCKETT, Harlem Hospital, N. Y. City. Age 24. Blank cartridge wound, left hand, July 4th. No tetanus bacilli found. Period of incubation, 10 days; trismus, abdominal muscles rigid; general convulsions 4 days later; treatment began on fourth day; continued 9 days. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, on fourth, fifth, sixth and twelfth days, injection preceded by withdrawal of cerebrospinal fluid amounting to 3610 m. Injections of 20 c.c. each. Total amount injected, 80 c.c. Steady improvement, sat up in bed on fifteenth day. Discharged well on twentieth day.

CASE 12.—H. G. MUDD, St. Luke's Hospital, St. Louis. Age 26. Small opening in left side scrotum, operation for varicocele. Tetanus bacilli found. Period of incubation, 7 days; very virulent; constant opisthotonos, with clonic spasms every few minutes; general convulsions; treatment began on second day; continued 1 day. Mulford's antitoxin used. Intraspinal injection of antitoxic serum administered daily, 1 injection, lumbar puncture. Total amount injected, 20 c.c. Death 16 hours after injection. Operation performed by man connected with advertising institution.

CASES OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM ADMINISTERED BY INTRAMUSCULAR INJECTION.

CASE 1.—C. B. G. DE NANCREDE, University of Michigan Hospital. Age 17. Injury from moving train. Compound fracture occipital bone and compound comminuted fracture right hand. Tetanus bacilli found. Period of incubation, 11 days; difficulty in opening mouth, trismus and dysphagia, later slight localized spasm; treatment began on first day; continued 9 days. P. D. & Co.'s antitoxin used. Intramuscular injection of antitoxic serum, every 4 hours for 9 days 10 c.c. Total amount injected, 540 c.c. Amputation forearm second day. Recovery.

CASE 2.—J. SHELTON HORSLEY, Memorial Hospital, Richmond, Va. Age 25. Gunshot wound right thigh, fracturing femur. Period of incubation, 5 days; clonic spasm right thigh and leg; after 18 hours violent general convulsions; general convulsions; treatment began on first day; continued 4 days. Mulford's antitoxin used. Intramuscular injection of antitoxic serum, deep thigh injections attempting to enter nerves without exposing them, 10 c.c. every 8 hours. Total amount injected, 120 c.c. Death on fourth day.

CASE 3.—ANDREW SLOAN, St. Luke's, Utica. Age 12. Slight cartridge wound left hand. No tetanus bacilli found. Period of incubation, 11 days; trismus, tonic contractions muscles legs, back, abdomen, face, thorax, arms; second day; T. 102°–104°; treatment began on third day; continued 6 days. N. Y. S. D. of H.'s antitoxin used. Intramuscular injection of antitoxic serum administered daily, twice daily deep into thigh 60 c.c. Total amount injected, 720 c.c. Extensive urticaria. Additional medication, chloral, bromides, morphia. Gradual recovery.

CASE 4.—R. R. CANNA, King's County Hospital, Brooklyn. Age 49. Punctured wound of foot. Tetanus bacilli found. Trismus, clonic convulsions, opisthotonos. N. Y. City Board of Health's antitoxin used. Intramuscular injection of antitoxic serum administered daily, every 4 hours in doses of 20–40 c.c. Death in coma.

CASE 5.—R. R. CANNA, King's County Hospital, Brooklyn. Age 37. Punctured wound, foot; rusty nail. Tetanus bacilli found. Period of incubation, 3 days; difficult swallowing, trismus, opisthotonos; general convulsions; treatment began on third day; continued 1 day. N. Y. City Board of Health's antitoxin used. Intramuscular injection of antitoxic serum administered daily, every 4 hours 40 c.c. Total amount injected, 240 c.c. Death on fourth day in coma.

CASE 6.—R. R. CANNA, King's County Hospital, Brooklyn. Age 40. Rusty nail penetrated ball big toe. Mixed infection. Tetanus bacilli found. Period of incubation, 11 days; trismus, opisthotonos, unable to swallow; general convulsions, severe; treatment began on first day; continued 1 day. N. Y. City Board of Health's antitoxin used. Intramuscular injection of antitoxic serum 2 injections, each 40 c.c. Total amount injected, 80 c.c. Death second day after admission.

Case 7.—Robt. W. Johnson, Maryland General Hospital, Baltimore, Md. Age 18. Slight laceration palm left hand and powder burn, blank cartridge. Period of incubation, 5 days; stiffness of jaws, gradually growing worse, dysphagia; entered hospital third day; general convulsions; treatment began third day; continued 3 days. Mulford's antitoxin used. Intramuscular injection of antitoxic serum administered daily, injections 20 c.c. each; third day one, and one every 4 hours for next 3 days. Total amount injected, 380 c.c. Death on sixth day.

Case 8.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 28. Slough from burn, dorsum right foot; fell on stove during attack of epilepsy. No tetanus bacilli found. Period of incubation, 15 days; stiffness jaw muscles, gradually growing worse; general convulsions on second, fourth and fifth days; treatment began on second day; continued 16 days. Intramuscular injection of antitoxic serum administered daily, second, third, fourth, and seventh to sixteenth days 10 c.c. once daily into thigh muscles, sixth day 2 injections each 10 c.c. Total amount injected, 140 c.c. Recovery. Gradual improvement. Discharge on sixteenth day.

Case 9.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 53. Punctured wound, foot. Rusty nail. Tetanus bacilli found. Period of incubation, 9 days; stiffness muscles neck, back; trismus moderate; rigidity muscles abdomen, back and neck; dysphagia; 1 slight convulsion; treatment began on second day; continued 6 days. Intramuscular injection of antitoxic serum, twice daily 60 m., increased to 70 m. twice daily deep into thigh. Total amount injected, 65 c.c. Death on seventh day.

Case 10.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 42. Contused and encrusted wound, bridge of nose. Period of incubation, 6 days; stiffness jaw, increasing to pronounced trismus, marked delirium and restlessness, pain and difficulty in breathing; treatment began on second day; continued 6 days. Intramuscular injection of antitoxic serum, second day once, after this twice daily 10 c.c. deep into thigh. Total amount injected, 110 c.c. Death on seventh day.

Case 11.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 40. End index finger cut off, sewed on and healed. Period of incubation, 10 days; stiffness jaws and neck; risus sardonicus; admitted fourth day of disease; treatment began on fourth day; continued 2 days. Intramuscular injection of antitoxic serum, on 4th day 30 c.c., on fifth day 20 c.c., deep into thigh. Total amount injected, 50 c.c. Death on sixth day.

Case 12.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 25. Punctured wound, sole right foot, rusty nail, incised 24 hours later. No tetanus bacilli found. Period of incubation, 10 days; admitted fourth day with trismus, general clonic spasms; general convulsions; treatment began on fourth day; continued 3 days. Intramuscular injection of antitoxic serum fourth day 10 c.c. on admission, after this 10 c.c. three times daily deep into thigh. Total amount injected, 100 c.c. Death on seventh day.

Case 13.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 18. Laceration, dorsal structures, left foot. Laceration great toe right foot. Amputation left foot and great toe of right foot within 2 hours after injury. No tetanus bacilli found. Period of incubation, 7 days; stiffness jaws and neck; general convulsions, rigid abdominal muscles; general convulsions; treatment began on first day; continued 5 days. Intramuscular injection of antitoxic serum, 20 c.c. daily deep into thigh muscles. Total amount injected, 100 c.c. Death on fifth day.

Case 14.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 21. Punctured wound, outer side sole right foot. Period of incubation, 25 days; stiffness of jaws; this disappeared; cramps in abdomen, opisthotonos, no rigidity arms or legs; convulsions; general convulsions; treatment began on first day; continued 4 days. Intramuscular injection of antitoxic serum first day 50 c.c. into muscles of thigh; second day 60 c.c. into muscles of thigh; third and fourth days 20 c.c. into muscles of thigh. Total amount injected, 150 c.c. No injections for 72 hours before death as there was apparent improvement. Then sudden death.

CASE 15.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 8. Superficial clean granulating wound left ankle, 5 cm. in diameter, no foreign body, no suppuration. Period of incubation, 8 days; dysphagia, rigidity muscles neck, trismus, rigid abdomen; general convulsions; treatment began on second day; continued 1 day. Intramuscular injection of antitoxic serum, 20 c.c. into gluteal muscles. Total amount injected, 20 c.c. Death third day in violent convulsions.

CASE 16.—C. A. PORTER, Massachusetts General Hospital. Age 40. Traumatic amputation of fingers; axe. No tetanus bacilli found. Period of incubation, 13 days; stiffness of jaw, backache, slight risus; T. 99.2°, P. 102, R. 26; general convulsions, one; treatment began on fourth day. Intramuscular injection of antitoxic serum, 10 c.c. into deltoid q. 4 hours. Recovery in 21 days.

CASE OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM ADMINISTERED BY INTRACEREBRAL INJECTION.

CASE 1.—Rhode Island Hospital. Age 24. Punctured wound, foot; rusty nail. Period of incubation, 6 days; continued 1 day. Intracerebral injection of antitoxic serum, 1 injection. Death 2 days after admission.

CASE OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM ADMINISTERED BY INTRAVENOUS INJECTION.

CASE 1.—C. A. PORTER, Massachusetts General Hospital. Age 52. Following operation for removal uterine polyp. No tetanus bacilli found. Period of incubation, 7 days; risus; symptoms severe; emprosthotonos; T. 100°, P. 84, R. 17; treatment began first day; continued 2 days. Intravenous injection of antitoxic serum, 30 c.c.–40 c.c. q. 4 hours. Convulsions followed each injection. Death 48 hours after admission.

CASES OF TETANUS TREATED BY SUBCUTANEOUS INJECTION OF ANTITOXIN MADE AND FURNISHED BY THE NEW YORK STATE DEPARTMENT OF HEALTH.

CASE 1.—R. H. TEDFORD; private. Age 14. Blank cartridge wound of hand improperly dressed. Period of incubation, 5 days; general convulsions ninth day; treatment began on ninth day; continued 10 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, twice daily for first 10 days, once daily thereafter. 50 c.c. Total amount injected, 1350 c.c. Effect of antitoxin doubtful. Chronic case. Recovery.

CASE 2.—F. F. SMITH; private. Age 24. Five-inch cut by buzz saw which had been cutting old wood. Period of incubation, 11 days; stiffness of left leg 3 days before any other symptom; treatment began on fifth day; continued 7 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 50 c.c. twice daily. Total amount injected, 700 c.c. Chronic case. Recovery.

CASE 3.—D. C. MORIATA; private. Age 14. Laceration of knee. Period of incubation, 18 days; stiffness of neck, jaw, face, and body; general convulsions seventh day; treatment began third day; continued 8 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 100 c.c. once daily. Total amount injected, 800 c.c. Improvement after fifth injection. Chronic case. Recovery.

CASE 4.—C. E. CAMPBELL; private. Age 30. Extensive laceration of hand by cannon fire-cracker. Period of incubation, 11 days; general convulsions second day; treatment began second day; continued 16 days. Mulford's and N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 10 c.c. q. 4 to 6 hours. Total amount injected, 1460 c.c. Subacute case. Recovery.

Case 5.—G. W. Green; private. Boy. Compound fracture of humerus under dirty conditions. Period of incubation, 6 days; general convulsions first day; treatment began first day; continued 4 hours. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 90 c.c. in divided doses. Total amount injected, 90 c.c. Very acute case. Death second day.

Case 6.—H. E. Phelps; private. Age 24. Slight cartridge wound of finger. Period of incubation, 8 days; general convulsions first day; treatment began first day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 20–50 c.c. twice daily. Total amount injected, 170 c.c. Acute. Death on third day.

Case 7.—F. R. Calkins; private. Slight wound, palm of hand. Period of incubation, 5 days; general convulsions within 4 hours; treatment began second day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 20 c.c. 1 injection. Total amount injected, 20 c.c. Acute. Death on third day.

Case 8.—Henry Fields; private. Age 35. Compound Pott's fracture. Period of incubation, 10 days; trismus; general convulsions early; not severe; treatment began first day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 20 c.c. 1 injection. Total amount injected, 20 c.c. Acute. Death on third day.

Case 9.—Frank H. Flood; private. Age 12. Laceration of great toe by bicycle. Period of incubation, 9 days; sore throat; general convulsions within 4 hours; treatment began on second day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. at 1 injection. Total amount injected, 50 c.c. Acute. Death on second day, 3 hours after injection.

Case 10.—L. S. Merritt; private. Age 16. Toe crushed between cars. Period of incubation, 3 days; dysphagia; general convulsions within 12 hours; very severe; treatment began on third day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 30 c.c. at 1 injection. Total amount injected, 30 c.c. Acute. Death on third day.

Case 11.—Period of incubation, 5 days; general convulsions 12 hours after onset; very severe; treatment began second day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin 500 c.c. at 1 injection. Total amount injected, 500 c.c. Acute. Death on second day.

Case 12.—J. B. Conant; private. Boy. Penetrating wound, left palm, by cartridge. Period of incubation, 10 days; general convulsions second day; treatment began second day; continued 2 days. Mulford's and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, twice daily 10 c.c.–40 c.c. Total amount injected, 90 c.c. Death on eighth day.

Case 13.—C. D. Kline; private. Boy. Cartridge wound of hand with wad remaining in hand. Period of incubation, 8 days; general convulsions 8 hours after onset; very severe; treatment began on first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 20 c.c. once daily. Total amount injected, 40 c.c. Death on second day.

Case 14.—W. W. Taylor; private. Age 65. Laceration of elbow in machinery. Period of incubation, 10 days; spasm of biceps of injured arm; general convulsions third day, not severe; treatment began fifth day; 1 injection. P. D. & Co.'s antitoxin used. Subcutaneous injection. Total amount injected, 80 c.c. Death on eighth day.

Case 15.—M. B. Davis; private. Age 26. Crushed finger. Period of incubation, 8 days; stiff neck; general convulsions third day; severe on fourth day; treatment began on twelfth day; continued 6 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, each injection 30–50 c.c. Total amount injected, 300 c.c. Gradual recovery.

Case 16.—Private. Cartridge wound of hand. Period of incubation, 8 days; stiff neck and sore throat; general convulsions within 48 hours; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 10 c.c. q. 12 hours. Total amount injected, 80 c.c. Death on fourth day.

Case 17.—Alice M. Perrigo (head nurse), Mineola Hospital, Mineola, N. Y. End of finger crushed by hammer. Period of incubation, 10 days; possible convulsion on fifth day; treatment began on fifth day; continued 1 day. Mulford's antitoxin used. Subcutaneous injection of antitoxin administered daily, 4 injections, each 20 c.c. Total amount injected, 80 c.c. Death on sixth day.

Case 18.—Jas. H. McGan; private. Crushed foot. Period of incubation, 5 days; general convulsions 48 hours; severe. Mulford's antitoxin used. Death on fourth day.

Case 19.—Coryell Clark; private. Childbirth. Period of incubation, 6 days; general convulsions 36 hours; severe; treatment began second day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 1 injection daily, 20 c.c.–80 c.c. Total amount injected, 170 c.c. Death on sixth day.

Case 20.—Geo. S. Skiff; private. Nail wound of foot. Period of incubation, 7 days; general convulsions third day; treatment began third day; continued 3 days. Subcutaneous injection of antitoxin, 400 units daily. Total amount injected, 2800 units. Death on seventh day. Antitoxin doubtful, possibly diphtheritic.

Case 21.—L. C. Green; private. Nail wound of foot. Period of incubation, 7 days; general convulsions second day; severe; treatment began second day; continued 1 day. Subcutaneous injection of antitoxin, 2 injections, 20 c.c. each. Total amount injected, 40 c.c. Death on fifth day.

Case 22.—C. I. Redfield; private. Age 6 months. Burn, second degree, on thumb. Period of incubation, 10 days; trismus; general convulsions ninth day; only a few; treatment began on fifth day; continued 4 days. Mulford's antitoxin used. Subcutaneous injection of antitoxin, 20 c.c. once daily. Total amount injected, 80 c.c. Death on ninth day.

Case 23.—Cassar Smith; private. Age 13. Lacerated wound, left knee. Malaise and trismus; general convulsions first day; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered, 50 c.c. daily. Total amount injected, 100 c.c. Death on second day.

Case 24.—W. L. Clark; private. Age 30. Nail puncture of wrist. Period of incubation, 3 days; pain in back of neck, stiffness of neck, throat and jaw muscles; pain and contraction in wrist 2 days after injury; treatment began on first day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered, 10 c.c. once daily. Total amount injected, 30 c.c. Recovery.

Case 25.—W. A. Leonard; private. Age 5½. Nail wound, left foot. Period of incubation, 7 days; sore throat, stiffness muscles of jaw, œsophagus and neck; general convulsions 48 hours; treatment began fourth day; continued 10 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin 20 c.c. q. 4 hours. Total amount injected, 560 c.c. Recovery.

Case 26.—D. C. Moriata, Saratoga Hospital, Saratoga Springs. Age 45. Crushed shoulder by machinery at tannery. Period of incubation, 6 days; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. three times daily. Total amount injected, 300 c.c. Death on third day.

Case 27.—A. E. Ilett, Watertown City Hospital, Watertown, N. Y. Age 4. Compound fracture forearm. Period of incubation, 7 days; jerky muscles and opisthotonos; general convulsions 48 hours; treatment began on first day;

continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 3 injections 10 c.c. each. Total amount injected, 30 c.c. Death on second day.

Case 28.—R. Gerrais; private. Age 7. Wound of foot by broken glass. Period of incubation, 22 days; contracture of masseters; no general convulsions; treatment began on first day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. 1 injection. Total amount injected, 50 c.c. Recovery. Prognosis would have been good without antitoxin.

Case 29.—W. W. Jamieson; private. Age 3 years, 10 months. Rusty nail-head perforated right side of head. Period of incubation, 4 days; treatment began on first day; continued 4 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 15 c.c.–50 c.c. twice daily. Total amount injected, 265 c.c. Death on fourth day.

Case 30.—H. M. Reinhardt; private. Age 23. Old nail injury to foot. Period of incubation, 8 days; some trismus, slight pain back of neck; general convulsions fifth day; treatment began on fifth day; continued 5 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 90 c.c.–150 c.c. once daily. Total amount injected, 590 c.c. Recovery.

Case 31.—Robt. C. Mehnert, German Hospital of Buffalo, N. Y. Age 16. Rusty nail wound right foot. History incomplete, admitted in convulsions; general convulsions probably quite frequent; chloroform used; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 2 injections 50 c.c. each. Total amount injected, 100 c.c. Death on following day.

Case 32.—Adolph Hoerr; private. Age 32. Nail wound, hand. Period of incubation, 6 days; marked local contraction of hand; general convulsions 39 hours after onset; treatment began on second day; continued 3 days. N. Y. S. D. of H.'s and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxin, 40–90 c.c. twice daily. Total amount injected, 400 c.c. Death on fifth day. Apparently hypostatic pneumonia.

Case 33.—G. E. Walker; private. Age 10½. Sliver in knee removed with unclean pocket-knife. Period of incubation, 12 days; general convulsions second day; treatment began fourth day; continued 6 days. N. Y. S. D. of H.'s and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxin 10 c.c. injected once or twice daily. Total amount injected, 100 c.c. Recovery. Case questionable.

Case 34.—H. M. Reinhardt; private. Age 7. Lacerated wound sole of foot. Period of incubation, 14 days; general convulsions first day; treatment began on first day; continued 5 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. twice daily. Total amount injected, 400 c.c. Recovery.

Case 35.—A. R. Warner, Cohoes City Hospital, Cohoes, N. Y. Age 15. Cartridge wound base of fingers. Period of incubation, 8 days; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c.–100 c.c. daily. Total amount injected, 150 c.c. Death on second day.

Case 36.—John Nugent; private. Age 60. Nail puncture left foot. Period of incubation, 9 days; general convulsions very mild on third day; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s and Mulford's antitoxin used. Subcutaneous injection of antitoxin, 40 c.c.–60 c.c. daily. Total amount injected, 100 c.c. Death on third day.

Case 37.—Chas. C. Sweet, Samaritan Hospital, Troy, N. Y. Age 28. Crushed right hand in corn husker. Period of incubation, 12 days; no general convulsions; treatment began on second day; continued 6 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. q. 6 hours. Total amount injected, 900 c.c. Recovery. Serum used locally.

Case 38.—A. F. Wright; private. Age 11. Abrasion on toe. Period of incubation, 13 days; general convulsions on sixth day; continued sixteenth day. N. Y. S. D. of H.'s and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxin, 10 c.c.–40 c.c. for 5 injections. Total amount injected, 80 c.c. Recovery.

CASE 39.—F. E. LEWIS; private. Age 12. Clean cut on hand. Period of incubation 11 to 12 days; general convulsions; date questionable; treatment began on sixth or seventh day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 20 c.c. for 3 injections. Total amount injected, 60 c.c. Death on eighth or ninth day.

CASE 40.—CHAS. C. SWEET, Samaritan Hospital, Troy, N. Y. Age 28. Crushed right hand in corn husker. Period of incubation, 12 days; trismus and dysphagia; no general convulsions; treatment began on second day; continued 6 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 50 c.c. q. 6 hours. Total amount injected, 950 c.c. Gradual recovery.

CASE 41.—W. J. CARR; private. Age 34. Nail wound of foot. Period of incubation, 5 days; trismus; general convulsions on third day; treatment began on third day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 1 injection 50 c.c. Total amount injected, 50 c.c. Death on fourth day.

CASE 42.—H. W. SCHLAFFI, German Hospital, Buffalo, N. Y. Age 16. Contusion and laceration of leg. Period of incubation, 12 days; treatment began second day; continued 4 days. Subcutaneous injection of antitoxin, 50 c.c. daily subcutaneously; 50 c.c. daily deep into muscle. Total amount injected, 400 c.c. Death on fifth day.

CASES OF TETANUS TREATED BY INJECTION, INTO VARIOUS STRUCTURES, OF ANTITOXIN MADE AND FURNISHED BY THE NEW YORK STATE DEPARTMENT OF HEALTH.

CASE 1.—A. W. ELTING; private. Age 35. Abortion. Period of incubation, 8 days; trismus; general convulsions seventh day; treatment began on eleventh day; continued 6 days. P. D. & Co.'s, Behring and N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, eleventh to fourteenth days q. 6 hours = 10 c.c.; fourteenth to eighteenth days 8 injections; total, 1050 c.c. Intraspinal injection, subdural, 150 c.c. Total amount injected, 1200 c.c. Some sleep and rest after some of the injections. Subacute case, slow recovery.

CASE 2.—A. W. ELTING; private. Age 57. Nail wound of foot. Period of incubation, 10 days; pain and stiffness of jaws and neck; general convulsions third day; treatment began on second day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 450 c.c. = 6 injections. Intraspinal injection, lumbar puncture, 3 injections, 50 c.c. each. Total amount injected, 600 c.c. Improvement following use of antitoxin. Death in spasm on fifth day from arterio-sclerosis. Tetanus was not progressing.

CASE 3.—A. W. ELTING; private. Age 14. Nail wound of foot. Period of incubation, 7 days; trismus—marked local contraction injured leg third day; general convulsions third day; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 6 injections = 270 c.c., 20 c.c.-50 c.c. Intraspinal injection, 50 c.c., 1 injection. Total amount injected, 320 c.c. Some relief from subdural injection; none from subcutaneous. Death on fourth day.

CASE 4.—C. H. TRAVELL; private. Age 27. Punctured wound of foot. Period of incubation, 7 days; stiffness muscles face and jaw; general convulsions third day; treatment began on sixth day; continued 4 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 6 injections = 270 c.c. Intraspinal injection, 2 injections, 80 c.c. Total amount injected, 350 c.c. Marked improvement from subdural injection, subcutaneous no effect. Recovery.

CASE 5.—SHELDON VORHEES; private. Age 53. Burns, third degree, legs. Period of incubation, 17 days; trismus; treatment began first day; continued 8 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 12 injections = 10 c.c.–100 c.c. each. Intraspinal injection, 1 injection 100 c.c. Total amount injected, 840 c.c. Chronic case; poor general condition. Death on eighth day.

CASE 6.—W. J. CARR; private. Age 55. Traumatic amputation of toes by threshing machine. Period of incubation, 7 days; dysphagia and trismus; general convulsions fourth day; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 5 c.c. twice. Intravenous injection, 100 c.c. Total amount injected, 110 c.c. Death on third day.

CASE 7.—R. M. VOSE; private. Age 45. Punctured wound of foot; nail. Period of incubation, 10 days; general convulsions 28 hours after onset; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 2 injections, 20 c.c. and 30 c.c. Intraspinal injection, 1 injection 30 c.c. Total amount injected, 80 c.c. Death in 65 hours.

CASE 8.—F. J. PARMENTER and ROSWELL PARK; private. Age 9. Tack wound of foot. Period of incubation, 7 days; stiffness in neck; general convulsions third day; treatment began on second day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 1 injection. Intraneural injection, 30 c.c. Intraspinal injection, 1 injection. Total amount injected, 80 c.c. Death on third day.

CASE 9.—A. VANDERVEER; private. Age 8. Compound fracture of forearm, penetration of bone into dirt of lawn. Period of incubation, 5 days; pain in injured arm and trismus; treatment began on first day; continued 1 day. Subcutaneous injection of antitoxic serum, 50 c.c.–100 c.c. Intraspinal injection, 50 c.c. Total amount injected, 200 c.c. Death on second day.

CASE 10.—A. VANDERVEER, Albany City Hospital, Albany, N. Y. Age 6. Cartridge wound right hand. Period of incubation, 7 days; trismus; general convulsions; under chloroform most of time; treatment began second day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 50 c.c. Intraspinal injection, 30 c.c. Total amount injected, 80 c.c. Death on second day.

CASE 11.—MARSHALL CLINTON; private. Age 24. Compound comminuted fracture right femur. Period of incubation, 5 days; general convulsions first day; treatment began on first day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 40 c.c.–50 c.c. Intraspinal injection, 10 c.c. Total amount injected, 100 c.c. Death on third day.

CASE 12.—A. GILBERT; private. Age 20–22. Thrown from train, long wound right calf. Period of incubation, 6 days; general convulsions first day; treatment began first day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 50 c.c.–100 c.c.–100 c.c. Intraspinal injection, 7 c.c. of 25 per cent. $MgSO_4$ solution. Total amount injected, 250 c.c. +. Death on third day.

CASE 13.—JOHN W. RILEY; private. Age 26. Crack in left thumb. Period of incubation, 11 days; spasm of masseters and neck muscles; general convulsions second day; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c., 50 c.c., 70 c.c., 50 c.c. Intraspinal injection, 50 c.c. Total amount injected, 250 c.c. Death on second day.

CASE 14.—MARSHALL CLINTON; private. Age 14. Wound of foot with pitchfork. Period of incubation, 12 days; stiffness of jaw and neck; general convulsions second day; treatment began second day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 14 injections, 50 c.c. each. Intraneural injection, 5 c.c. Intraspinal injection, 5 c.c., 6 c.c. Total amount injected, 716 c.c. Recovery.

CASE 15.—R. O. CROISER; private. Age 38. Punctured wound of foot.

Period of incubation, 6 days; stiffness of jaw and neck; general convulsions second day; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 4 injections, 10 c.c. each. Intraneural injection, 10 c.c. Total amount injected, 50 c.c. Death on third day.

Case 16.—W. J. Carr; private. Age 10. Pistol shot wound index finger. Period of incubation, 5 days; general convulsions first day; treatment began on first day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Intraneural injection, 8 c.c. Intravenous injection, 40 c.c. Total amount injected, 48 c.c. Death on second day.

CASE OF TETANUS TREATED BY INTRACEREBRAL INJECTION OF ANTITOXIN MADE AND FURNISHED BY THE NEW YORK STATE DEPARTMENT OF HEALTH.

Case 1.—H. W. Nash; private. Boy. Cartridge wound of hand. Period of incubation, 7 days; general convulsions 7 hours, very severe; treatment began second day; continued, 2 injections. N. Y. S. D. of H.'s antitoxin used. Intracerebral injection of antitoxin administered daily, 2 injections 5 c.c. each. Total amount injected, 10 c.c. Death in convulsion, second day.